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The Great Piltdown Hoax

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WHEN Drs. J. S. Weiner, K. P. Oakley, and W. E. Le Gros Clark (*1*) recently announced that careful study had proven the famous Piltdown skull to be compounded of both recent and fossil bones, so that it is in part a deliberate fraud, one of the greatest of all anthropological controversies came to an end. Ever since its discovery, the skull of "Piltdown man" —termed by its enthusiastic supporters the "dawn man" and the "earliest Englishman"—has been a veritable bone of contention. To place this astounding and inexplicable hoax in its proper setting, some account of the facts surrounding the discovery of the skull and of the ensuing controversy seems in order.

Charles Dawson was a lawyer and an amateur antiquarian who lived in Lewes, Sussex. One day, in 1908, while walking along a farm road close to nearby Piltdown Common, he noticed that the road had been repaired with peculiar brown flints unusual to that region. These flints he subsequently learned had come from a gravel pit (that turned out to be of Pleistocene age) in a neighboring farm. Inquiring there for fossils, he enlisted the interest of the workmen, one of whom, some time later, handed Dawson a piece of an unusually thick human parietal bone. Continuing his search of the gravel pit, Dawson found, in the autumn of 1911, another and larger piece of the same skull, belonging to the frontal region. His discoveries aroused the interest of Sir Arthur Smith Woodward, the eminent paleontologist of the British Museum. Together, during the following spring (1912), the two men made a systematic search of the undisturbed gravel pit and the surrounding spoil heaps; their labors resulted in the discovery of additional pieces of bone, comprising—together with the fragments earlier recovered by Dawson—the larger part of a remarkably thick human cranium or brain-case and the right half of an apelike mandible or lower jaw with two molar teeth *in situ* (*2*). Continued search of the gravel pit yielded, during the summer of 1913, two human nasal bones and fragments of a turbinate bone (found by Dawson), and an apelike canine tooth (found by the distinguished archeologist, Father Teilhard de Chardin) (*3*). All these remains constitute the find that is known as Piltdown I.

Dawson died in 1916. Early in 1917, Smith Woodward announced the discovery of two pieces of a second human skull and a molar tooth (*4*). These form the so-called Piltdown II skull. The cranial fragments are a piece of thick frontal bone representing an area absent in the first specimen and a part of a somewhat thinner occipital bone that duplicates an area recovered in the first find. According to Smith Woodward's account, these fragments were discovered by Dawson early in 1915 in a field about two miles from the site of the original discovery.

The first description of the Piltdown remains, by Smith Woodward at a meeting of the Geological Society of London on December 18, 1912 (*2*), evoked a controversy that is probably without equal in the history of paleontological science and which raged, without promise of a satisfactory solution, until the studies of Weiner, Oakley, and Clark abruptly ended it. With the announcement of the discovery, scientists rapidly divided themselves into two main camps representing two distinctly different points of view (with variations that need not be discussed here) (*5*).

Smith Woodward regarded the cranium and jaw as belonging to one and the same individual, for which he created a new genus, *Eoanthropus*. In this monistic view toward the fragments he found ready and strong support. In addition to the close association within the same gravel pit of cranial fragments and jaw, there was advanced in support of this interpretation the evidence of the molar teeth in the jaw (which were flatly worn down in a manner said to be quite peculiar to man and quite unlike the type of wear ever found in apes) and, later, above all, the evidence of a second, similar individual in the second set of skull fragments and molar tooth (the latter similar to those imbedded in the jaw and worn away in the same unapelike manner). A few individuals (Dixon [*6*], Kleinschmidt [*7*], Weinert [*8*]), moreover, have even thought that proper reconstruction of the jaw would reveal it to be essentially human, rather than simian. Reconstructions of the skull by adherents to the monistic view produced a brain-case of relatively small cranial capacity, and certain workers even fancied that they had found evidences of primitive features in the brain from examination of the reconstructed endocranial cast (*9, 10*)—a notoriously unreliable procedure; but subsequent alterations of reconstruction raised the capacity upward to about 1400 cc—close to the approximate average for living men (*10,* p. 596).

A number of scientists, however, refused to accept the cranium and jaw as belonging to one and the same kind of individual. Instead, they regarded the brain-case as that of a fossil but modern type of man and the jaw (and canine tooth) as that of a fossil anthropoid ape which had come by chance to be associated in the same deposit. The supporters of the monistic view, however, stressed the improbability of

the presence of a hitherto unknown ape in England during the Pleistocene epoch, particularly since no remains of fossil apes had been found in Europe later than the Lower Pliocene. An anatomist, David Waterston, seems to have been the first to have recognized the extreme morphological incongruity between the cranium and the jaw. From the announcement of the discovery he voiced his disbelief in their anatomical association (*11*, p. 150). The following year (1913) he demonstrated that superimposed tracings taken from radiograms of the Piltdown mandible and the mandible of a chimpanzee were "practically identical"; at the same time he noted that the Piltdown molar teeth not only "approach the ape form, but in several respects are identical with them." He concluded that since "the cranial fragments of the Piltdown skull, on the other hand, are in practically all their details essentially human . . . it seems to me to be as inconsequent to refer the mandible and the cranium to the same individual as it would be to articulate a chimpanzee foot with the bones of an essentially human thigh and leg" (*12*).

In 1915, Gerrit Miller, curator of mammals at the United States National Museum, published the results of a more extensive and detailed study of casts of the Piltdown specimens in which he concluded that the jaw is actually that of a fossil chimpanzee (*13*). This view gradually gained strong support, e.g., from Boule (*14*) and Ramström (*15*). Miller, furthermore, denied that the manner of wear of the molar teeth was necessarily a peculiarly human one; he stated that it could be duplicated among chimpanzees. That some other workers (Friederichs [*16*]; Weidenreich [*17*]) have ascribed the jaw to a fossil ape resembling the orangutan, rather than to a chimpanzee, is unimportant. What is important, in the light of recent events, is that the proponents of the dualistic theory agreed in pronouncing the jaw as that of an anthropoid ape, and as unrelated to the cranial fragments. Piltdown II remained a problem; but there was some ambiguity about this discovery, which was announced after the death of Dawson "unaccompanied by any direct word from him" (*5*). Indeed, Hrdlička (*18*), who studied the original specimens, felt convinced that the isolated molar tooth of Piltdown II must have come from the original jaw and that there was probably some mistake in its published history.

A third and in a sense neutral point of view held that the whole business was so ambiguous that the Piltdown discovery had best be put on the shelf, so to speak, until further evidence, through new discoveries, might become available. I have not attempted anything resembling a thorough poll of the literature, but I have the distinct impression that this point of view has become increasingly common in recent years, as will be further discussed. Certainly, those best qualified to have an opinion, especially those possessing a sound knowledge of human and primate anatomy, have held largely—with a few notable exceptions—either to a dualistic or to a neutral interpretation of the remains, and hence have rejected the monistic interpretation that led to the reconstruction of a "dawn man." Most assuredly, and contrary to the impression that has been generally spread by the popular press when reporting the hoax, "Eoanthropus" has remained far short of being universally accepted into polite anthropological society.

An important part of the Piltdown controversy related to the geological age of the "Eoanthropus" fossils. As we shall see, it was this aspect of the controversy that eventually proved to be the undoing of the synthetic Sussex "dawn man." Associated with the primate remains were those of various other mammals, including mastodon, elephant, horse, rhinoceros, hippopotamus, deer, and beaver (*2*). The Piltdown gravel, being stream-deposited material, could well contain fossils of different ages. The general opinion, however, seems to have been that it was of the Lower Pleistocene (some earlier opinions even allocated it to the Upper Pliocene), based on those of its fossils that could be definitely assigned such a date (*2*). The age of the remains of "Piltdown man" thus was generally regarded as Lower Pleistocene, variously estimated to be from 200,000 to 1,000,000 years (*19*). To the proponents of the monistic, "dawn-man" theory, this early dating sufficed to explain the apparent morphological incongruity between cranium and lower jaw.

In 1892, Carnot, a French mineralogist, reported that the amount of fluorine in fossil bones increases with their geological age—a report that seems to have received scant attention from paleontologists. Recently, K. P. Oakley, happening to come across Carnot's paper, recognized the possibilities of the fluorine test for establishing the relative ages of bones found within a single deposit. He realized, furthermore, that herein might lie the solution of the vexed Piltdown problem. Consequently, together with C. R. Hoskins, he applied the fluorine test to the "Eoanthropus" and other mammalian remains found at Piltdown (*20*). The results led to the conclusion that "all the remains of *Eoanthropus* . . . are contemporaneous"; and that they are, "at the earliest, Middle Pleistocene." However, they were strongly indicated as being of late or Upper Pleistocene age, although "probably at least 50,000 years" old (*19*). Their fluorine content was the same as that of the beaver remains but significantly less than that of the geologically older, early Pleistocene mammals of the Piltdown fauna. This seemed to increase the probability that cranium and jaw belonged to one individual. But at the same time, it raised the enigma of the existence in the late Pleistocene of a human-skulled, large-brained individual possessed of apelike jaws and teeth—which would leave "Eoanthropus" an anomaly among Upper Pleistocene men. To complete the dilemma, if cranium and jaw were attributed to two different animals—one a man, the other an ape—the presence of an anthropoid ape in England near the end of the Pleistocene appeared equally incredible. Thus the abolition of a Lower Pleistocene dating did not solve the Piltdown problem. It merely produced a new problem that was even more disturbing.

As the solution of this dilemma, Dr. J. S. Weiner advanced the proposition to Drs. Oakley and Clark that the lower jaw and canine tooth are actually those of a modern anthropoid ape, deliberately altered so as to resemble fossil specimens. He demonstrated experimentally, moreover, that the teeth of a chimpanzee could be so altered by a combination of artificial abrasion and appropriate staining as to appear astonishingly similar to the molars and canine tooth ascribed to "Piltdown man." This led to a new study of all the "Eoanthropus" material that "demonstrated quite clearly that the mandible and canine are indeed deliberate fakes" (*1*). It was discovered that the "wear" of the teeth, both molar and canine, had been produced by an artificial planing down, resulting in occlusal surfaces unlike those developed by normal wear. Examination under a microscope revealed fine scratches such as would be caused by an abrasive. X-ray examination of the canine showed that there was no deposit of secondary dentine, as would be expected if the abrasion had been due to natural attrition before the death of the individual.

An improved method of fluorine analysis, of greater accuracy when applied to small samples, had been developed since Oakley and Hoskins made their report in 1950. This was applied to the Piltdown specimens. The results of these new estimations, based mainly on larger samples, are given in the first and second columns of the accompanying table. Little elaboration is necessary. The results clearly indicate that whereas the Piltdown I cranium is probably Upper Pleistocene in age, as claimed by Oakley and Hoskins, the attributed mandible and canine tooth are "quite modern." As for Piltdown II, the frontal fragment appears to be Upper Pleistocene (it probably belonged originally to Piltdown I cranium), but the occipital fragment and the isolated molar tooth are of recent or modern age. The foregoing conclusions are supported by evidence concerning the organic content of the specimens, as determined by analysis of their nitrogen content. This method is not as conclusive as fluorine analysis; but its results, given in the third column of the accompanying table, provide additional support for the conclusions arrived at by the fluorine-estimation method. In general, as would be expected, the nitrogen content decreases with age; the only specimen that falls out of line is the occipital of Piltdown II.

Weiner, Oakley, and Clark also discovered that the mandible and canine tooth of Piltdown I and the occipital bone and molar tooth of Piltdown II had been artificially stained to match the naturally colored Piltdown I cranium and Piltdown II frontal. Whereas these latter cranial bones are all deeply stained, the dark color of the faked pieces is quite superficial. The artificial color is due to chromate and iron. This aspect of the hoax is complicated by the fact that, as recorded by Smith Woodward (*21*), "the colour of the pieces which were first discovered was altered a little by Mr. Dawson when he dipped them in a solution of bichromate of potash in the mistaken idea that this would harden them." The details of the staining, which confirm the conclusions arrived at by microscopy, fluorine analysis, and nitrogen estimation, need not be entered into here.

TABLE 1. Fluorine content, ratio of fluorine to phosphorus pentoxide, and nitrogen content of the bones and teeth of the so-called Piltdown I and Piltdown II skulls, compared with those of various Upper Pleistocene and Recent bones and teeth. From Weiner, Oakley, and Clark (*1*), rearranged.

	% F	$\frac{\% F \times 100}{\% P_2O_5}$	% N
Upper Pleistocene			
Bones (local) (minimum F content)	0.1	0.4	—
Teeth, dentine (minimum F content)	0.1	0.4	—
Bone (London)	—	—	0.7
Equine molar, dentine (Piltdown)	—	—	1.2
Human molar, dentine (Surrey)	—	—	0.3
Recent			
Neolithic bone (Kent)	—	—	1.9
Fresh bone	—	—	4.1
Chimpanzee molar, dentine	< 0.06	< 0.3	3.2
Piltdown I			
Cranium	0.1	0.8	1.4
Mandible, bone	< 0.03	< 0.2	3.9
Mandibular molar, dentine	< 0.04	< 0.2	4.3
Canine	< 0.03	< 0.2	5.1
Piltdown II			
Frontal bone	0.1	0.8	1.1
Occipital bone	0.03	0.2	0.6
Isolated molar, dentine	< 0.01	< 0.1	4.2

In conclusion, therefore, the *disjecta membra* of the Piltdown "dawn man" may now be allocated as follows: (1) the Piltdown I cranial fragments (to which should probably be added Piltdown II frontal) represent a modern type of human brain-case that is in no way remarkable save for its unusual thickness and which is, at most, late Pleistocene in age; (2) Piltdown I mandible and canine tooth and Piltdown II molar tooth are those of a modern anthropoid ape (either a chimpanzee or an orangutan) that have been artificially altered in structure and artificially colored so as to resemble the naturally colored cranial pieces—moreover, it is almost certain that the isolated molar of Piltdown II comes from the original mandible, thus confirming Hrdlička's (*18*) earlier suspicion; and (3) Piltdown II occipital is of recent human origin, with similar counterfeit coloration.

Weiner, Oakley, and Clark conclude that "the distinguished palaeontologists and archaeologists who took part in the excavations at Piltdown were the victims of a most elaborate and carefully prepared hoax" that was "so extraordinarily skilful" and which "appears to have been so entirely unscrupulous and inexplicable, as to find no parallel in the history of palaeontological discovery."

It may be wondered why forty years elapsed before

the hoax was discovered. Two factors enter here: first, there was no reason at all to suspect the perpetration of a fraud, at least, not until fluorine analysis indicated the relative recency of all the specimens, thus making the association of a human cranium and an anthropoid-ape jaw, either anatomically or geologically, hardly credible; and, second, methods for *conclusively* determining whether the specimens were actual fossils or faked ones, short of their wholesale destruction, were developed only in recent years (it will be recalled that even the fluorine-estimation method used by Oakley and Hoskins a few years ago was inadequate for detecting a significant difference between brain-case and jaw). It is of interest to note that Dawson, in his original report (*2*), stated: "A small fragment of the skull has been weighed and tested by Mr. S. A. Woodhead, M.Sc., F.I.C., Public Analyst for East Sussex & Hove, and Agricultural Analyst for East Sussex. He reports that the specific gravity of the bone (powdered) is 2.115 (water at 5° C. as standard). No gelatine or organic matter is present. There is a large proportion of phosphates (originally present in the bone) and a considerable proportion of iron. Silica is absent." This statement obviously refers to the brain-case alone; for, in both the title and text of the original report the authors spoke of "skull *and* mandible" (italics mine). One cannot help but wonder what might have come to pass if samples of the jaw and teeth had also been submitted to chemical analysis, even though the present, more refined methods were not then available.

The ready initial acceptance of the Piltdown discovery at its face value, at least by a majority of interested scientists, can probably be attributed to the philosophical climate that invested the problem of human evolution at that time. In September, 1912, before the announcement of the discovery of "Piltdown man," the distinguished anatomist, Elliot Smith, in an address before the Anthropological Section of the British Association for the Advancement of Science at Dundee (*22*), expressed a prevailing point of view when he developed the theory that the brain led the way in the evolution of man and that modification of other parts of the body followed. Thus the stage was set for the ready acceptance of the Piltdown fragments as constituting a single individual, a "dawn man" possessing a human cranium housing a human brain, but with phylogenetically laggard, hence simian, jaws and teeth. To quote the paleontologist, Sollas (*23*): "The surprise which was first excited by what appeared to be a monstrous combination disappears on further reflection. Such a combination had, indeed, been long previously anticipated as an almost necessary stage in the course of human development. . . . In *Eoanthropus Dawsoni* we seem to have realised precisely such a being . . . , one, that is, which had already attained to human intelligence but had not yet wholly lost its ancestral jaws and fighting teeth." And, as Sir Arthur Keith, perhaps the most vocal champion of "Eoanthropus," argued in supporting this view: ". . . before the anthropoid characters would disappear from the body of primal man, the brain, the master organ of the human body, must first have come into its human estate. Under its dominion the parts of the body such as the mouth and hands, the particular servants of the brain, became adapted for higher uses. Looking at the problem from this point of view, we cannot reject the Piltdown mandible because as regards the mylo-hyoid ridge it is simian and not human in character" (*10*).

Recent finds of fossil men and other primates, however, indicate that it is the brain that was the evolutionary laggard in man's phylogeny; indeed, the studies of Tilly Edinger (*24*) of the phylogeny of the horse brain suggest that this may well be a general rule in mammalian evolution. It was such concepts as this, leading to a change in philosophical climate, that evoked an increasing skepticism toward the validity of the monistic interpretation of the Piltdown fragments and led in turn to what appears to have been the prevailing recent opinion, namely, that the fragments should, as expressed in 1949 by Le Gros Clark (*25*), "be laid aside without further comment until more evidence becomes available." This view, enhanced by the redating of the remains by Oakley and Hoskins, provided the proper psychological setting for the *coup de grâce* delivered by Weiner, Oakley, and Clark.

As the three latter point out, the solution of the Piltdown enigma greatly clarifies the problem of human evolution. For "Eoanthropus," both morphologically and geologically, just simply did not fit into the picture of human evolution that has gradually been unfolding as the result of paleontological discoveries throughout the world.

The Piltdown story is a significant one in the history of ideas, more particularly as it bears on the concept of the precise course of human evolution. For, if man's biological history be likened to a book, it is seen to be composed of both blank and written pages and, by those who note them carefully, many if not most of the written ones will be seen to be in the nature of palimpsests—pages that have been rewritten after their original writing has been rubbed out. Of this, the Piltdown affair is a striking demonstration. It is a demonstration, furthermore, that the palimpsest nature of the pages of man's history is not always due directly to new fossil discoveries but can also result from changes in the philosophical climate of the science. That this phenomenon is peculiar to anthropology, however, is seriously to be doubted.

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A Differential Ability of Strains of Tobacco Mosaic Virus to Bind Host-Cell Nucleoprotein[1]

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ONE OF THE PROBLEMS facing workers engaged in the purification of viruses and other proteins is the tendency for these large molecules to associate with other substances derived from the host tissue. It is recognized that a virus can form complexes with a wide range of substances (*1, 2*). Some of these complexes are rather stable whereas others are easily dissociable. Several examples of complexes between plant or animal viruses and host cell constituents have been cited by Pirie (*2*), who pointed out that such combinations are of limited interest unless they can be shown to be specific or related to some biological process or property. Tobacco mosaic virus (TMV) is particularly notorious in that different methods of purification yield preparations of varying degrees of color.

It is the purpose of this paper to report a selective ability of certain strains of TMV to form a stable complex with a nucleoprotein derived from the host cells, and to describe the conditions under which the complex may be dissociated.

It has been found possible to assign the strains of TMV being investigated in this laboratory into groups on the basis of biological, physical-chemical, and serological methods (*3*). Viruses of Group I are differentiated from each other by the symptoms they cause in *Nicotiana tabacum* and serologically, but the strains are indistinguishable with respect to the following characteristics: electrophoretic mobility, isoelectric point, ultraviolet absorption spectrum, and rate of inactivation by ultraviolet radiation. The strains within Group II are distinguishable also by symptoms and serology and are indistinguishable from each other by the above criteria, but the characteristics of the latter strains are sharply differentiated from the Group I viruses.

It is noteworthy that strains within Group I, of which common TMV is an example, are uniformly obtained as clear amber pellets on purification by ultracentrifugation in cacodylate buffer, whereas strains of Group II are colorless after the same treatment. The color remains associated with Group I viruses even after they are precipitated with acids or ammonium sulfate, or dialyzed at length against monovalent buffer salts in the range of pH 5–8 (e.g., acetate, cacodylate, and Veronal). The virus-color complex withstands freezing and thawing, and also precipitates as a complex when reacted with homologous antiserum. It cannot be dissociated by electrophoresis or by repeated ultracentrifugation. By these criteria the colored substance appears to be rather firmly bound to the virus molecule.

The virus-color complex can, however, be dissociated by exposure to various di- and polyvalent anions. The phenomenon was first noted in the course of attempts to remove the color enzymically. It was observed that virus in the control tubes, which was suspended in phosphate buffer during incubation, was obtained in nearly colorless pellets on centrifugation. Subsequent experiments showed that although the colored material after removal from the virus by phosphate treatment is readily separated by centrifugation, it cannot be separated by dialysis. Phosphate has been used in most of our investigations, although the effect is not limited to this ion.

After preliminary experiments indicated that the decolorization is not instantaneous at room temperature, the effect of temperature on the rate of the dissociation was studied. Clear amber pellets of strain

[1] This work was supported in part by the Atomic Energy Commission, Contract AT(11-1)-34, and by Cancer Research Funds of the University of California.

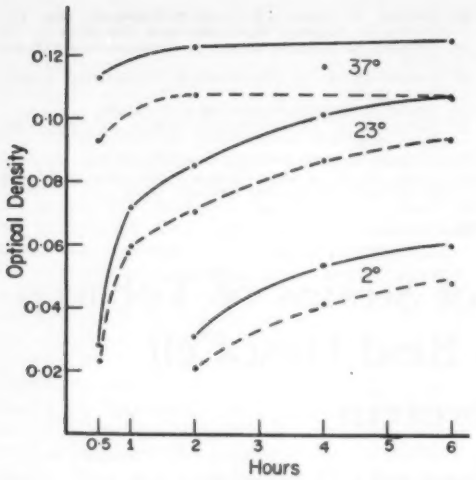

FIG. 1. The effect of temperature on the rate of decolorization of common TMV in 0.1 *M* phosphate buffer at pH 7.0. Optical density of supernatant liquid measured after removal of virus by ultracentrifugation. Solid line determined at 260 millimicrons, broken line at 280.

U1 (common TMV, a Group I strain), purified by four or more cycles of high- and low-speed centrifugation in cacodylate buffer, were dissolved in distilled water and the final protein concentration was adjusted to 0.25 percent. Forty-milliliter aliquots of this solution were centrifuged at 30,000 rpm in the No. 30 rotor of the Spinco preparative centrifuge for one hour and the supernatant solutions discarded. The pellets were rapidly dissolved by stirring in 40 ml of pH 7 phosphate buffer (0.1 *M*), and the virus solutions were held at 2°, 23°, and 37°. Ten-milliliter aliquots were taken after various time intervals, the reaction arrested by rapid cooling to 0°, and virus protein removed by centrifuging in a precooled No. 40 Spinco rotor at 40,000 rpm for one hour. The amount of colored material released from the virus was estimated by measuring the optical density of the supernatant solutions at 260 and 280 millimicrons. These wavelengths were selected somewhat arbitrarily because the color exhibits no absorption peaks in the visible or near ultraviolet except for a broad maximum near 260 millimicrons. Absorption in the ultraviolet is much greater than in the visible and thus gives a more sensitive measure of dissociation. The spectrophotometer blank was prepared from a virus sample dissolved in 10 milliliters of the same buffer and centrifuged in similar fashion at zero time. Thus, the observed optical density cannot be attributed to stray virus in the supernatant solution. The results, showing that rate of decolorization is markedly dependent on temperature, are presented in Fig. 1.

The effect of phosphate concentration on the rate of decolorization of virus is shown in Fig. 2. This experiment was conducted in exactly the same manner as the preceding one except that the temperature was held at 23° and the concentration of pH 7 phosphate buffer was varied as indicated. The dissociation is markedly dependent on phosphate concentration. It is of particular interest that the rate at 0.1 *M* is about ten times the rate at 0.05 *M*, since buffers in this concentration range are frequently used for virus purification. It is probable that all these samples would have been eventually completely decolorized, since exposure of the colored virus for a month to phosphate concentrations as low as 0.02 *M* at 4° has given colorless virus. Conversely, virus pellets have been obtained with no appreciable decolorization if worked up rapidly at low temperature in *M*/15 phosphate. It will be seen that wide variations in color may result from differences in technique of preparation, especially in the widely used 0.1 *M* phosphate buffer.

It was subsequently found that certain divalent and polyvalent anions have an effect equal to or greater than that of phosphate in causing the release of color. The ions were tested at pH 7 in 0.1 *M* solutions. The order of effectiveness of these compounds is: versene, citrate, and oxalate > phosphate, arsenate, malate, and tartrate > succinate, maleate, phthalate, sulfate, acetate, and malonate. Fumarate and cacodylate cause no detectable decolorization. It is of interest that (omitting the nonchelating inorganic ions and monovalent organic ions) the above order is the same as that for the stability constants of the calcium chelate complexes of these ions (*4*). It would seem likely that replacement of the colored material on the virus surface by the anions may be involved in the dissociation.

Removal of the colored material does not measurably change any of the physical-chemical character-

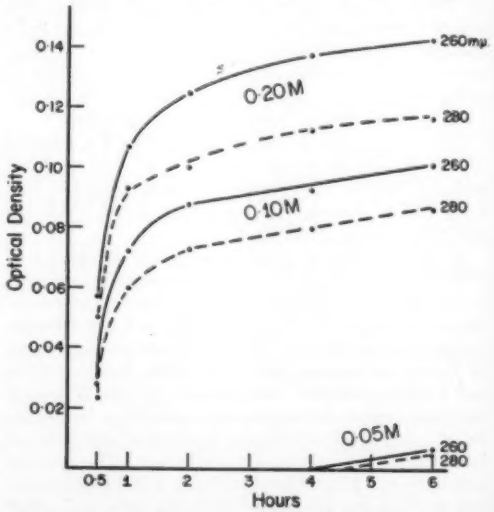

FIG. 2. The effect of phosphate buffer concentration on the rate of decolorization of common TMV at pH 7.0, temperature 23° C.

istics used to differentiate between the groups of strains. The infectivity of the virus is also unaltered after decolorization.

Colored material for analysis was obtained in the following manner. Several grams of the colored virus were prepared from infected leaves of *N. tabacum* by five cycles of alternate high- and low-speed centrifugation in cacodylate buffer and two additional cycles in double distilled water. At the end of this treatment, the supernatant solutions were water clear and the compacted virus pellets were dark amber in color. The pellets were then dissolved in 0.1 *M* phosphate at pH 7. The solutions were transferred to cellophane bags and dialyzed against a large volume of the same buffer at 4° for four days. As reported above, the dissociated colored material will not diffuse through the membrane, but can be separated from the virus by centrifugation. Contents of the dialysis bags were centrifuged at 30,000 rpm in the No. 30 Spinco rotor. The supernatant solution, containing the colored material in 0.1 *M* phosphate, was dialyzed against distilled water and then concentrated to a small volume at 4° by directing an air stream against the dialysis bag. The concentrated solution was centrifuged for three hours at 30,000 rpm to remove any final traces of virus and virus fragments, and then dialyzed against three changes of pH 6.83 cacodylate buffer ($\mu = 0.1$; NaCl 0.08 *M*, cacodylate 0.02 *M*) for six days.

The electrophoretic mobility in this buffer was -12×10^{-5} cm^2/v/sec compared with -8.9×10^{-5} for the parent virus. The boundaries migrated as single peaks with a trace of a minor component on either shoulder of the main peaks. The nitrogen/phosphorus ratio was determined to be 4.6 and 4.8 for two separate preparations of the brown material. Nitrogen was determined by the Nessler method and phosphorus by the Berenblum and Chain method (*5*). This ratio suggests a nucleic acid content of 34 percent, assuming the remainder to be protein with a nitrogen content of 16 percent. Pentose was estimated by the Meijbaum orcinol method (*6*), using yeast nucleic acid as a standard (*7*). The nitrogen/pentose ratio of about 0.9 further indicates a nucleic acid content of 37 percent. The colored material thus appears to be about six times as rich in nucleic acid as the parent virus which contains 6 percent nucleic acid. About 1/500 of the nitrogen of the virus was recovered in the brown material.

A sample of the colored material was treated with trichloroacetic acid, and the precipitate was hydrolyzed in a sealed tube at 120° for 16 hours with 6 *N* HCl. A two-dimensional chromatogram was made of an aliquot estimated (on the assumption that the colored material is 60 to 70 percent protein) to contain about 160 micrograms of amino acids. A parallel chromatogram was run on 160 micrograms of a mixture of equal parts of seventeen amino acids, and good separation was obtained. Most of the spots on the two sheets were superposable, and the approximate agreement in size and color intensity on spraying with ninhydrin indicated the presence of protein in the experimental sample at roughly the level proposed above. Thus, the material dissociated from the virus appears to be nucleoprotein in nature. Whereas the nucleoprotein may be intrinsically colored, it is perhaps more likely that its color is due to adherent small molecules. Whatever its nature, the coloring material appears to be firmly bound to the nucleoprotein, and no means for its removal have been found.

The colored nucleoprotein, once released, is not readsorbed by the parent virus. However, when the decolorized virus is mixed with a homogenate of uninfected fresh tobacco leaves and is then recovered in cacodylate buffer, the virus is again obtained as a characteristic brown pellet. This suggests that unaltered nucleoprotein is required and that the colored material may be irreversibly altered in the process of dissociation or subsequent handling, losing the necessary configuration for attachment to the virus. Under the same conditions strain U2 (a Group II strain) does not pick up any color from the fresh leaf homogenate. The observations suggest that the association of color with Group I viruses is due to configurational differences between the two groups of strains.

The problem of whether the colored virus complexes are artifacts of preparation or the colored material is normally associated with the virus in the host cell is difficult to resolve. It is clear at any rate that a marked difference in affinity for the colored material exists between the groups of strains that were originally differentiated by other criteria. Subtle differences in surface configuration of the virus molecules may account for these different affinities, just as they are assumed to account for immunological differences. It seems possible that selective affinities for other cellular components may exist and that these differences might be related to specific symptoms exhibited by virus infected plants.

The results of the present investigation seem of interest in that they demonstrate a differential ability of virus strains to bind a nucleoprotein derived from the host cell, they indicate the ability of di- and polyvalent anions to cause dissociation in a manner suggestive of displacement, and they may reconcile differences in degrees of coloration of tobacco mosaic virus preparations obtained by various workers using different methods of purification.

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Robert Andrews Millikan: 1868-1953

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THE death of Robert Andrews Millikan on December 19, 1953, in his 86th year, marks the passing of one of the greatest figures in American science and in American higher education. As a physicist, educator, and public-spirited citizen Dr. Millikan led a career of high achievement which can be matched by few men of this century.

Born in Morrison, Illinois, March 22, 1868, the son of Silas Franklin Millikan, a Congregational minister, and the former Mary Jane Andrews, one time a dean at Olivet College, young Robert led the robust life of a typical midwestern small town boy. There he acquired the tremendous physical vigor which served him for over four score years.

He received his A.B. from Oberlin College in 1891 and his M.A. in 1893, after having transferred his field of interest from physical education to physics as a result of being asked to serve as a substitute teacher in the latter subject. He went on to receive his Ph.D. in physics in 1895 from Columbia University where his most inspiring teacher was Michael Pupin. Dr. Pupin, aware that the American scientific community was then, to put it mildly, not very mature, urged Millikan to study in Europe—which he did on borrowed funds but with great profit in 1895–96.

Dr. Millikan often said that Providence could have done him no greater service—if he were intended to be a physicist—than to plunge him into the exciting physics laboratories of England, Germany, and France during the closing years of the 19th century. His associations with Poincaré, Planck, Warburg, Kelvin, Helmholtz, J. J. Thomson, Roentgen, Becquerel, and others inspired him with an enthusiasm for the "new physics" which was still burning brightly over fifty years later. He revisited his friends in Europe many times in subsequent years and indeed for many years kept in close personal touch with practically every leading physicist in the world.

On his return to the States in 1896, Millikan went to the University of Chicago where he remained until moving to Pasadena in 1921. In 1902 he married Greta Blanchard (who preceded him in death by only 68 days) and they had three sons: Clark B., now professor of aeronautics at the California Institute of Technology, Max F., now professor of economics at Massachusetts Institute of Technology, and Glenn A., who was a physiologist at Vanderbilt at the time of his tragic death in a mountaineering accident in 1947.

Dr. Millikan has done the world a great service by setting forth in his autobiography the story of his experiences, of his activities, and of his thoughts as he recalled them in 1949 at the age of 81. He describes therein his scientific achievements and his extracurricular activities with such clarity and enthusiasm that there is hardly need to try to repeat them here. It may, however, be useful to try to select a few topics to illustrate the startling combination of brilliance, foresight, perseverance, enthusiasm, and versatility that made Millikan such a great figure.

Millikan was, of course, first and always a research physicist. In reviewing his many contributions one is profoundly impressed by his keen insight and intuition. Sometimes he appears to have had an almost miraculous foresight. He always chose the right experiment at the right time. In 1908 he realized that quantitative evidence of the atomic nature of electricity was a key problem in physics. Although most physicists of the day already took the electron for granted, it was not clear that it was the universal element of charge. Indeed, the various experimental values for the electronic charge differed from one another so widely that many scientists argued that no single discrete unit of charge existed. The story of how Millikan selected the oil-drop method as the most promising tool for this investigation, of how he refined this technic almost beyond belief, traced down and reduced sources of error, and came out with a proof that all electric charges are multiples of a fundamental unit is one of the sagas of modern physics. The final value of e which he arrived at in 1913 (4.774×10^{-10} esu) and which he refined and confirmed in 1916 remained the accepted value for twenty years. Even then it was altered only because a new determination of the viscosity of air showed the old value to be slightly in error, thus raising the value of e computed from Millikan's oil-drop data to 4.8025×10^{-10} esu, approximately the presently accepted value.

This achievement, resulting from eight years of most intensive effort, would have been almost a "life work" for many men. (Millikan was 48 years old in 1916). But for him it was only his opening gun. Even before completing his first decisive work on e in 1913 he had begun a second major task—one that revealed the same sort of intuition and perseverance. This time he sought to test the "atomicity of light" as assumed by Einstein in formulating his photoelectric equation. Others had made approximate tests of Einstein's equation and had obtained values of the Planck constant h. But no decisively accurate data had been obtained. Millikan again showed great foresight in selecting his experimental method of attack and the most extraordinary ingenuity and perseverance in eliminating sources of difficulty and error. His "machine shop in vacuum" was one of the great experimental achievements of its day. This work yielded a value of h/e, the accuracy of which was not surpassed for two

decades, and he thus decisively established the quantum theory of light.

For these two experiments Millikan was awarded the Nobel prize in physics in 1923—the second American physicist to be so honored (Michelson was the first). These two projects also were the chief subject of the first edition of his famous book *The Electron*, published in 1917, a book which, with its successive ever expanding editions, has been required reading for graduate students in physics up to the present day.

Dr. Millikan had embarked on two other ambitious series of experiments by the time he left the University of Chicago in 1921. One series began with some experiments with electric sparks in vacuum which led him and his student and colleague, I. S. Bowen, into exhaustive studies of the far ultraviolet spectra of stripped atoms. These extended the known ultraviolet spectrum from the previous limit of 600 A down to 200 A and also revealed those spectral features that were later to be important evidence for the concept of the spinning electron, introduced by Uhlenbeck and Goudsmit in 1927.

The second series of experiments began with investigations of the ionization of the air at high altitudes, following up the balloon measurements reported earlier by Hess and Kolhörster, which showed that the ionization increased rapidly with altitude. Thus began the monumental work on what he named the "cosmic rays." By 1923 he had discovered the enormous penetrating power of the cosmic rays. In 1930 he and Carl Anderson, then a graduate student, had begun the cloud-chamber experiments which measured the energies of cosmic-ray particles directly, and led to the discovery by Anderson of the positron and the meson. For twenty-five years Millikan tracked cosmic rays to the four corners of the globe and as late as 1947, at the age of 79, he personally led his last expedition, sending instrument-bearing balloons to altitudes of 100,000 ft above the western plains from Texas to Saskatchewan. Even then, as always, he was the most tireless member of the party.

Millikan's achievements in research, and there were many others, would have been remarkable enough for a man who never did anything else. But the fact that he seldom worked less than eighteen hours a day enabled him to pursue simultaneously *two* other careers —one as an educator and one as a public-spirited citizen.

Immediately after his arrival in Chicago at the invitation of A. A. Michelson in 1896, Millikan began reorganizing the physics curriculum there, developing a teaching laboratory, and writing new textbooks. His books attained great popularity; there is hardly anyone who took high school and college physics during the years 1900–1925 who did not use a Millikan textbook, and one of them is still widely used.

In 1917 he began to spend a part of each year in Pasadena, directing the organization of a physics laboratory at Throop College of Technology. These visits were interrupted by World War I but in 1921, on the promise of a new physics building and the assurance of adequate funds for research, he transferred full time from Chicago to the tiny unknown institution which had by then been renamed the California Institute of Technology. He became director of the new Norman Bridge Laboratory of Physics and was also asked to be president of the Institute. However, he preferred to share the administrative burdens with others and hence proposed the creation of an executive council of which he would be chairman. George Ellery Hale, director of the Mt. Wilson Observatory, and A. A. Noyes, professor of chemistry, were two other original members of this Council. Although he had powerful support from these and others, there was never any doubt about who was the leader of the Institute.

Thus began the task of building a great center of research and education in science and technology. Within a miraculously short span of time, Caltech had reached a position of world-wide recognition. Millikan captured the imagination of the people of Southern California and of the large foundations. Starting from a small beginning in 1921, the assets of the Institute grew until today they total 55 million dollars. However, the goals he set were high, and this was only enough for the essential things. Indeed, there were many lean years, and Millikan used his great talent for frugality to the limit. But with the help of Hale, Noyes, and Thomas Hunt Morgan he collected such a distinguished group of scholars that Pasadena became a mecca for hosts of younger scholars, research fellows, and students. To the members of this ever-changing and always dynamic group, Millikan was "the Chief." Again, we see evidence of that great foresight which made him confident that Southern California was the right place to build a new institution of this type and that this was the type of institution this country needed.

Millikan's third career, that of public service, was a long and varied one. He was an active member of a host of scientific, professional, and civic agencies, committees, and organizations. But one of his great services to the world of science was his part in the organization and initial direction of the National Research Council. Millikan and Hale went to Washington early in 1917, before the United States entered World War I, to help mobilize a scientific defense effort. The NRC had just been organized for this purpose. Hale became the first chairman and designated Millikan as executive officer. Millikan simultaneously served (with the rank of major and later lieutenant-colonel) as director of research for the Signal Corps and thus personally supervised a wide range of research activities including submarine detection and airplane design. Hale and Millikan were truly the OSRD of World War I.

Millikan's interest in the National Research Council continued long after World War I, and as chairman he guided many of its peacetime activities. The most important of these was the NRC Fellowship Program, financed by the Rockefeller Foundation. This program was a decisive factor in building the United

States scientific strength between the two world wars.

The NRC fellowship program is but one example of what was clearly Millikan's greatest lifetime interest—the education and encouragement of talented young men. He was himself a gifted teacher who attracted and inspired students to a degree matched by few American scientists. A host of his former students now occupy positions of leadership in science, industry, and technology both here and abroad. Two have won Nobel prizes. He took a keen personal interest in each of his students, in their jobs, and in their families. At a Caltech dinner in honor of his 80th birthday he remarked that he was always amazed by the loyalty and friendship of his colleagues and students, "because," he said with a characteristic twinkle, "I have also loved all their wives."

His kindly good humor, friendly interest in people, and spell-binding ability on the platform made Robert A. Millikan one of the most loved and respected citizens of Southern California. His great and conspicuous achievements made him one of the most famous scientists of his day. He left to the world a threefold monument: his imperishable contributions to knowledge, his creation in Caltech of a new kind of scientific institution, and the inspiration he gave to hundreds of students.

The scientific community in America "grew up" between 1915 and 1940. It would be hard to find a man who contributed more to this maturing process than Robert A. Millikan.

Henry Albright Mattill: 1883-1953

Clarence P. Berg

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THE passing of Henry A. Mattill at Iowa City, Iowa, on March 30, 1953, is keenly felt by the many who knew him and found in him warm friendliness, quiet humor, and cordial scientific and personal companionship.

Dr. Mattill was born in Glasgow, Missouri, November 28, 1883, the son of the Reverend Henry and Emma Fryhofer Mattill. He received his A.B. degree from Adelbert College of Western Reserve University in 1906 and his A.M. in 1907. His Ph.D. in physiological chemistry was awarded by the University of Illinois in 1910. He taught physiology and physiological chemistry at the University of Utah from 1910 to 1915 and nutrition at the University of California at Berkeley from 1915 to 1918. During World War I he served as captain and major in the sanitary corps, division of food and nutrition. In 1919 he became professor of biochemistry in the Department of Vital Economics at the University of Rochester, and in 1927 professor and head of the Department of Biochemistry at the State University of Iowa. He retired to part-time status in July, 1952.

Dr. Mattill for many years edited a section of *Biological Abstracts*. He held memberships on the editorial boards of the *Proceedings of the Society for Experimental Biology and Medicine*, the *Journal of Nutrition*, and *Physiological Reviews*. He served the American Society of Biological Chemists as its secretary, as a member of its council, and as chairman of its editorial committee. At the time of his death he was the society's president. His associates found him keen in his perception and critical in his judgment, but always alert to human factors and diplomatic in his approach. His maturity of wisdom, his astute outlook, his ever soft voice, and his knack of introducing sly humor to ease embarrassment fitted him well for academic and scientific statesmanship.

His early research with P. B. Hawk was concerned with the effects of prolonged fasting on nitrogen partition and of variations in water-intake upon the utilization of foods. His subsequent observation that rats failed to reproduce when they were maintained on a diet whose proteins and vitamins were supplied entirely by whole milk powder introduced a fresh field of interest. His pioneering efforts in this area aided materially in the establishment of vitamin E as a reproductive factor. The more ready development of rancidity noted in animal fats, which lack this factor, led to studies which showed that vitamin E was itself an antioxidant and, like the other fat soluble vitamins, was often associated in tissue with substances that acted as inhibitors or stabilizers to delay the development of the rancidity in fats or the autoxidation of other substances. There followed an intensive program of investigation of the probable mechanism of antioxygenic action which associated the primary action with ortho and para di- and polyphenolic compounds and showed that their effect is prolonged synergistically by the addition of certain inorganic or organic acids that are inactive alone, and that still other acids act both as synergists and as stabilizers. Physiologically, alpha tocopherol was found to prevent the autoxidation of vitamin A in the intestine; the paralysis in the young rat deprived of vitamin E was shown to be a muscular, not a nervous lesion; the creatine output in the rabbit rendered dystrophic by the lack of the vitamin was observed to exceed that which could be accounted for by muscle breakdown; and the dystrophic muscle was found to have an increased oxygen uptake. From these studies

and those of numerous other investigators in the field no clear-cut metabolic pattern has yet emerged. Dr. Mattill's interest in the search for clues and his broad perspective are revealed in his last publication on vitamin E, in *Nutrition Reviews* 10, 225 (1952).

In 1950 he received the third annual Iowa Award of the American Chemical Society, in recognition of his teaching and of his research. In 1952 he was awarded the honorary degree of Doctor of Science by Western Reserve University.

Few men have been as genuinely and unselfishly interested in their associates on the staff and in their students as was Dr. Mattill. He took pride in his relationship with the 2000 or more medical students who had sat in his classes. He strove zealously to "cultivate unprejudiced objective thinking," to stimulate integration and correlation of factual material into functional concepts, and to aid in moulding well-rounded personalities.

In 1912 Dr. Mattill married Helen Isham, Ph.D., Cornell, 1906, then a member of the chemistry staff of the University of Illinois, who took a continuing and helpful interest in his work. He is survived by her and a married son, John I. Mattill of Concord, Massachusetts, director of publications of Massachusetts Institute of Technology. The Mattill home was a delightful one, as countless friends and students can testify. Dr. Mattill was an accomplished pianist and organist. Interest in stamp collecting and miniature photography brought him and John into an exceptionally happy father and son relationship.

Late in May, 1952, Dr. Mattill had submitted to surgery. Having apparently recovered well, he and Mrs. Mattill had gone to Havana, Cuba, to carry out his agreement to serve as an adviser that fall to the Foundation for Medical Investigation. He was forced to return to Iowa City in December for further medical attention. His condition proved to be malignant and steadily worsened, but to the last he kept his courage and his interest. From his sick-bed he had dictated an address on the nutritional requirements of man, to be read in Spanish at the dedication of the Cuban laboratories on January 26, 1953. His message closed with these words:

> It is our hope that the work which is being undertaken in the Laboratories of the Foundation for Medical Investigation in Nutrition may contribute to the improvement of the health and the welfare of the people of Cuba. However, obtaining data is not alone sufficient. For the realization of this goal, there must be men of good will willing to assist the less fortunate in their quest of a better and healthier life.

Such concern as this for his fellow traveler made journeying with him a refreshing experience.[1]

[1] This obituary is similar to one read before the American Society of Biological Chemists at its annual meeting in Chicago, April, 1953.

News and Notes

The First World Conference on Medical Education

THE First World Conference on Medical Education was held in London, Aug. 22–29, 1953, under the auspices of The World Medical Association, in collaboration with The World Health Organization, The Council for International Organizations of the Medical Sciences, and The International Associations of Universities. The general theme of the Conference was "Undergraduate Medical Education."

The official languages of the Conference were English, French, and Spanish. All seats were equipped with earphones and excellent direct translation from the speaker's language to the listener's language was available at all times. Over 600 registrants representing 62 countries participated.

Following the opening plenary session, the Conference divided into four working groups or sections: (A) Requirements for entry into medical schools; (B) Aims and content of the medical curriculum; (C) Technics and methods of medical education; (D) Preventive and social medicine. These sections conducted their programs under the supervision of a vice president and a "rapporteur" for three and a half days. A summary of the Conference was made by the vice presidents and "rapporteurs" of each of the sections during the final days.

The over-all Conference was well attended, papers were stimulating and thought provoking, and discussions thoroughly excellent. It was gratifying to find that regardless of the nation involved, the basic qualities being sought in people seeking to enter the medical profession are much the same the world over. The basic background and preparation of students for admission to the study of medicine had a fairly common denominator while the methods, technics, and actual needs in medical training itself varied greatly, depending upon the objectives being sought in various parts of the world to meet the specific needs of certain areas.

Outstanding addresses were given the first day by Sir Lionel Whitby, Regius Professor of Physic at Cambridge on "The Challenge to Medical Education in the Second Half of the Twentieth Century," and by Sir Richard Livingstone, formerly president, Corpus Christi College, Oxford, on "What is Education?" Both of these excellent addresses are printed in full in the Aug. 29, 1953, issue of the *British Medical Journal*. Sir Lionel levelled the first challenge of the new half-century at education itself rather than specifically at medical education. Regardless of what profession a student strives to enter today, the basic difficulty is essentially the same as in medicine, namely, that the accumulation of knowledge has reached such a state as to involve early specialization and to make it diffi-

cult or impossible for students to be as comprehensive in their approach as might be desired. He indicated that he felt there are three challenges: those directed at the teachers; those directed at those they teach; and those directed at what they teach.

Although the ideal teacher was discussed, the general conclusions as to the challenges to the teacher were that *presentation of material is as important as the material presented, and that courses or subjects presented in a way that repels students may be worse than useless.* Furthermore, it was indicated that the *"selection and appointment of teachers might well be more deliberate . . . that some may be chosen for their teaching capabilities."*

In the challenge to the students, the essential qualities desired in medical students were outlined in a pen-picture of the "ideal medical student." "Cultured, broadly educated in the humanities, intelligent and intellectual, of transparent integrity, humane and sympathetic, and above all, one who will love his profession as well as his fellow men and all their weaknesses, their joys, and their sorrows." Although it is not possible for any school to have all students with such ideal qualities, all students *"should have some of at least part of these qualities* either inherent or capable of development."

It was indicated that it is important in all countries that the medical professor have intellectual and social prestige and unquestioned integrity as well as technical competence. Educational background and personal qualifications of students are of such great overall importance that it is possible to generalize that "there is little point in making fine or even coarse adjustments in the medical curriculum if the soil is not fit to receive the seed."

Many questions centered around the challenge, "What is to be taught?" It was clearly indicated that education in medicine in any area must to some extent be related to the medical needs of the population. Questions were raised as to whether we were preparing students to grasp the basic principles underlying the tremendous scientific advances of recent years. At the same time it was indicated that currently there is a "poverty of mind in the finished medical and science graduates because of lack of general education in the humanities, literature, language, history, philosophy, and the arts." The medical student looking forward to becoming a physician must understand the world in which his patients live, and it is important that he know them as human beings through his own understanding and appreciation of civilized values. Too early a specialization and its inherent dangers in curbing perspective were reemphasized. Human ecology, the study of man in relation to his environment, continues to be one of the great current challenges to medical education if physicians are to have the perspective needed in their work today.

In discussing the "Objective of Undergraduate Medical Education," Sir Lionel pointed out that it should not be directed towards specifically training general practitioners, specialists, public health officials, or administrators, but should provide a student with the basic foundation on which he may build his future regardless of which branch of medicine is eventually selected. It should produce an educated individual well indoctrinated in "principle and method," trained to observe through the use of his senses, able and encouraged to think logically and critically, equipped with a knowledge of the use of instruments of measurement and with the basic information and attitudes on which to build a successful professional life.

"Are we as teachers doing this? Or is teaching just a by-product of our professional life? Do we positively examine ourselves from time to time with a critical eye, or do we complacently content ourselves with no more than getting the student over an examination hurdle?" These and many other questions were raised which every teacher of medicine, every departmental group, and every faculty group might well turn on themselves.

An outstanding address was given by Sir Richard Livingstone on "What is Education?" His basic thesis revolved around the concept that an education which leaves one without a philosophy of life is as incomplete as one that would leave one unable to think or to express ones thoughts. He then followed through with the idea that there is a very simple philosophy that gives standards of value and judgment applicable to all spheres and activities of human life, namely the "Philosophy of the First-Rate." He pointed out that all people, regardless of race or creed admit to what he termed the philosophy of the first-rate . . . and that "an educated man knows, and an uneducated man does not know, what is first-rate and that the best educated man is he who knows the first-rate in the most important human activities." One knows the first-rate only by seeing it, by contacting it . . . and thus as far as medicine is concerned those who teach it have a tremendous obligation to those who are on the receiving end, to be sure they are in a position to fully appreciate the first-rate . . . and to make it available to those subjected to their care in the future.

Doctor S. M. K. Mallick, dean of Dow Medical College, Karachi, Pakistan, raised the interesting question as to whether today's medicine is basically a "Technology or a profession?" Again the hazards of too early specialization and too narrow specialization were indicated as far as the basic training of the physician is concerned. Technical aspects of education in medicine need to be accorded their rightful consideration in terms of today's needs, but this phase of education must be consistent with the nature of the eventual duties and obligations of the physician later on.

Doctor John Fulton gave a resumé of the History of Medical Education which is recorded in full in the *British Medical Journal*, Aug. 29, 1953.

The Section on "Requirements for Entry into Medical Schools" covered such topics as: (1) General education in an age of science, (2) Teaching the history of science, (3) Teaching the scientific method, (4) Sci-

ence is measurement, (5) Biology fundamental to the study of medicine, (6) How much physics?, (7) How much chemistry?, (8) Introduction to the social sciences, (9) Selection of students, (10) Use and value of intelligence and aptitude tests, and (11) Method and value of the interview.

The increasing demands for more chemistry and physics as basic premedical requirements for admission to medicine were severely criticized by such outstanding men as Professor H. C. Burger of the Department of Physics at Utrecht and Professor E. C. Dodds of the Biochemistry Department of the University of London. They, and many others, advised serious rethinking as to the need for perspective in planning work in these areas for those anticipating the study of medicine. It was generally agreed in discussions that the objective of medical education was the training of physicians, not chemists or physicists, and that this is lost sight of by the specialist in these fields altogether too frequently. Serious rethinking and replanning of basic background needs in these areas is of major importance if the total program of training physicians is kept within reasonable bounds as far as time and objectives are concerned. As a matter of fact the final sentence in the summary of the deliberations of this section was to the effect "Let us be reasonable."

The section on "Aims and Content of the Medical Curriculum" considered: (1) Teaching of anatomy for the doctor, (2) Teaching of physiology for the doctor, (3) Integration of physiology and anatomy as a single subject in the curriculum, (4) Pathology, the basic clinical science, (5) Pharmacology and the new therapeutics, (6) Medical statistics and the design of experiment, (7) Aim of the medical curriculum, (8) Introductory clinical courses, (9) Teaching of psychological medicine, (10) Teaching of medicine and surgery as one discipline, (11) Teaching of minor surgery, (12) The doctor, the midwife, and obstetrics, (13) Teaching of pediatrics as a branch of medicine, (14) Place of the specialties in the curriculum, (15) Teaching of tropical medicine, (16) Is an intern year necessary?, (17) The undergraduate and general practice, and (18) The balanced curriculum.

How much anatomy and what kind of anatomy for the medical student are just as pertinent questions as how much and what kind of physics or chemistry are basically essential for the premedical major. Getting rid of traditional departmental barriers where they constitute hurdles to effective integrated or cooperative teaching constitutes a problem of major importance in most medical schools. Seriously raising the question as to complete deletion of a traditional department or combining two or more traditional departments into a single more comprehensive and potentially more effective department almost approaches the realm of heresy. But these are the things people interested in today's medical education all over the world are discussing seriously. It is one of the reasons why a self-evaluation, such as our study by the Committee on Objectives of Medical Education, should be an almost continuous process in all medical schools worthy of the name.

The point at which introductory clinical courses should be introduced into the curriculum varies widely in different countries and in the schools within a given nation. Suffice it to say there is no standard pattern and there is no pattern that was presented that can be more effective than the personnel behind it. It was obvious that early exposure to patients without intelligent program planning or objectives could mean little, whereas, early patient contacts in a well-designed program with clean-cut objectives means the addition of perspective of great value in undergraduate medical education.

Real leadership in curriculum planning is, therefore, one of the great modern challenges faced by a medical school administration and its faculty.

In the section on "Techniques and Methods of Medical Education," the following topics were discussed: (1) The hospital bedside teaching of medicine, (2) Teaching surgery at the bedside and in the theater, (3) Teaching in the O.P.D. or polyclinic, (4) Teaching in the home, (5) The C-P-C, (6) The laboratory in teaching experimental medicine, (7) Visual aids in education, (8) The one way observation screen, (9) Moving pictures in medical education, (10) The still picture, (11) Lecture and group discussion, (12) Medical education and the full-time system, (13) The place of the textbook in teaching, (14) Library and reference services, (15) Undergraduate teaching medical museum, (16) Teaching the teacher to teach, (17) The examination paper, (18) Practical and oral tests, and (19) Why students fail.

Some of the most important points of emphasis in this section centered around the intelligent use of our currently available teaching aids. Beautiful examples of the effective use and the effective abuse of such things as visual aids were demonstrated. A good slide should get over its message clearly and easily. Beautifully colored and complicated slides often fail to carry the message intended because they cover too much. The individual, observing for the first time, may completely lose or fail to gain the concept intended if visual material is too complicated. The same criticism holds for movies and their effective utilization. No visual, auditory, or other aid developed in medical teaching can be as effective as it should be unless there is an intelligent teacher behind it. It was obvious that many different methods and technics were in use in presenting almost every phase of medical education. It was fairly obvious that in those areas where thought, imagination, self-evaluation, and experimentation were being conducted by alert, interested faculties, that excellent programs could be effectively accomplished with different technics. The challenge here, as in other sections, refers back to the teacher, to those who are taught, and to not only what they are taught but how and why it is taught.

The section on Preventive and Social Medicine began with a panoramic discussion of the present status of the teaching of preventive and social medicine with

participants from France, U.S.A., U.K., Netherlands, Uruguay, Italy, and Canada. It was clearly pointed out that this section was dealing with social medicine, or ecology, and in no sense with socialized medicine. The following general topics were considered: (1) Social medicine as an academic discipline, (2) Teaching social medicine in the preclinical periods, (3) Social medicine in the clinical period, (4) The need for reorientation of teaching, (5) The teaching of epidemiology, (6) Demography and vital statistics, (7) The teaching of medical genetics, (8) The teaching of social psychiatry, (9) Social environment and individual illness, (10) The home setting in medical education, (11) Teaching occupational health, (12) Use of student health services in the education of the student, (13) Infant and child care as a medico-social problem, (14) The teaching of nutrition, (15) Housing in relation to health, and (16) Integration of the teaching of social medicine in the medical curriculum.

This section emphasized the tremendous importance of medical ecology today and the great concern that must be given it in undergraduate medical education. Repeatedly, this phase of medical education was indicated to be the area that offered best opportunity for the understanding of many of the factors that create health problems of both organic and functional nature. This is the area of medical education frequently unknown to, or inadequately known by, the individual who has specialized too soon or too narrowly. This is the aspect of medicine too frequently largely unknown to the basic medical scientist and therefore "side stepped" in many schools in the early medical indoctrination period. It is frequently one of the "blind spots" of the pure scientist as far as his knowledge of the needs in medical education are concerned.

It is of passing interest to note that this section of the Conference indicated that malnutrition is still the most widespread human medical problem as well as one of the greatest of social and economic problems. Those of us living in the U.S. and Canada have little or no concept of the magnitude of nutritional problems as they still exist in many other parts of the world.

Early introduction of the teaching of social medicine in the medical curriculum obviously has increasingly widespread acceptance throughout the entire world. Our U.S. schools have demonstrated genuine leadership in this facet of medical education even though continued resistance on a traditional basis has retarded such programs in some of our schools.

Full appreciation of the fact that medical education should not be standardized for all parts of the world was apparent. The needs of a physician in the U.S. as compared to those of the physician in the Sudan or in Japan vary with the type of medical problems encountered and with the socio-economic setting of the region to be served. It was, indeed, a pleasure to participate in a Conference of world-wide scope where there seemed to be so little area for disagreement, in so far as basic fundamentals are concerned. One can only wish that other world-wide problems might eventually be so readily adaptable to international accord, as far as basic fundamentals are involved.

EDWARD L. TURNER
American Medical Association
Chicago, Illinois

Science News

After nearly four years of intensive development, the **anti-malaria operations** of the government of Afghanistan, assisted by the World Health Organization and the UN Children's Fund, have resulted in successful control of the disease among approximately two-thirds of the total malarious population of the country, according to a report just received in the WHO Regional Office for Southeast Asia at New Delhi. The report, submitted jointly by the WHO senior malaria adviser in Afghanistan, S. L. Dhir, and the President of Afghanistan's National Malaria Organization, Abdul Rahim, cites significant economic benefits that have followed in the wake of malaria control operations now affording protection to more than 900,000 people.

Margaret Mead, Associate Curator of Ethnology at the American Museum of Natural History, has returned from a seven-month **expedition to the Admiralty Islands,** a United Nations mandate which is part of the Territory of Papua and New Guinea. The expedition was financed by a grant from the Rockefeller Foundation. Its primary purpose was to make a record of social change by re-examining adult members of a society who had previously been studied as children. The Manus village of Pere on the south coast of the Admiralties, where Dr. Mead made observations in 1928, proved the ideal place to make such a study, for the children she had worked with 25 years ago are now grown and have taken their place in the world.

According to Dr. Mead, the changes that have occurred in Manus society have been as dramatic as changes made in any culture in the world. "These people have moved from the edge of the Stone Age—from a warlike society in which they dressed like savages and were ignorant of the outside world," Dr. Mead said, "—to a point where they are interested in the most complex ideas of the mid-twentieth century." The world of the Manus today differs greatly from the atmosphere pictured by Dr. Mead in her book written about her first visit to these people, *Growing Up in New Guinea.* The greedy, quarrelsome adults she met in 1928 have given way to a younger generation that has been tempered by the best elements of modern civilization. Dr. Mead observed that these people have adopted new laws, new parent-child relationships, new marriage and courtship customs, and have even redesigned their clothes and their houses.

Dr. Mead also commented on the advances made in the field techniques of anthropology since she last visited the Admiralties. During her recent trip the most modern recording instruments and photographic

equipment took the place of the pencil and pad used in 1928. Expedition members used a stenotype machine, a tape recorder, telephoto lenses, electronic flash equipment, and infra-red film. Dr. Mead compared the gains made in anthropological techniques with the changes in Manus society. "The materials collected have increased one hundred-fold since the 1928 study. In place of the spears, shell necklaces, and carved wooden bowls showing man's early techniques and ingenuity, this time we have brought back film, observations, and sound recordings of how early man can become modern man in one generation. The anthropologist, like the natives, has stepped from the Stone Age into modern times."

Success in **grafting frozen male sex glands** in rats has been announced by A. S. Parks and A. U. Smith of the National Institute for Medical Research in a recent issue of the *British Medical Journal*. The report contains a hint, but no more than that, that the special freezing technique may make possible transplants of human gland tissue.

Success with the grafts resulted from a method in which the rat glands were frozen in material containing glycerol. The investigators had previously discovered that glycerol protects the spermatozoa from the otherwise fatal effects of freezing and thawing. Seven out of nine animals had grafts showing androgenic activity when the glands had been stored in a frozen state for as long as 22 weeks. The same method was used successfully for grafts of rat ovarian tissue.

According to reports of the Polish Academy of Sciences, one of its members, Prof. Wojciech Swietoslawski, has developed an improved method of **extracting naphthalene from coal tar.** During recent plant tests, employment of the Swietoslawski process increased the output of naphthalene by 60 percent.

A University of Miami microbiologist, Murray Sanders, has announced the development of a toxoid that has been effective on rhesus monkeys infected with **poliomyelitis.** The toxoid is derived from cobra venom and has worked on the monkeys "in a heretofore unequalled fashion." Dr. Sanders stated that the material had been used on humans and "has shown no untoward effects on them," but added, "We are not prepared to assert anything further."

An **x-ray camera** capable of studying materials at temperatures up to 4000° F has been developed at Oak Ridge National Laboratory. The camera is being used in ceramics research work by staff members of the Metallurgy Division of ORNL. Designed by J. R. Johnson, a technical adviser, the camera has been used successfully to produce diffraction patterns in studies of hafnium oxide, as well as a number of other oxides and metals.

To photograph the diffraction pattern of the material under study, x-rays produced in a standard x-ray tube pass through a tube guide mounted on the film holder, then through a small disk of beryllium and a collimator. The x-rays strike a rotating sample and are diffracted through a beryllium "window" and the pattern image is registered on photographic film.

Scientists in the News

Frank Brown Berry, a New York surgeon and professor of clinical surgery at Columbia University, has been appointed Assistant Secretary of Defense for Health and Medical Affairs. He succeeds **Melvin A. Casberg,** who is returning to private practice in Santa Ynes Valley Medical Center in Solvang, Calif.

At the 136th annual meeting of the New York Academy of Sciences the following awards were made.

The A. Cressy Morrison prizes in natural science of $300 each, which are given annually to the two most meritorious papers covering original research, were presented to **Robert Ginell,** Department of Chemistry, Brooklyn College, for his paper on "A general theory of association," and to **Bernhard Werner,** Helgoland Biological Institute, List a-Sylt Research Institute of the Federation of Fisheries, Helgoland, Germany, for his paper "On the development and reproduction of *Anthomedusa margelopsis haeckeli* Hartlaub."

The $300 George Frederick Kunz Prize in geology and mineralogy was awarded to **Samuel Katz,** Menlo Park, Calif., for his paper entitled "Seismic study of crustal structure in Pennsylvania and New York."

The $500 Boris Pregel Prize for work in the field of natural radioactive substances was awarded to **Philip Morrison** and **Jerome Pine** of Cornell University for their paper entitled "Radiogenic origin of the helium isotopes in rock."

George Edward Holbrook, assistant director of the development department of E. I. du Pont de Nemours & Co., Inc., Wilmington, has received the 1953 professional progress award in chemical engineering for "his remarkable record as a chemical engineer in his successive positions of directing research, development and plant production of organic chemicals and for his energetic public service in advancing the profession of chemical engineering." The award is sponsored by the Celanese Corporation of America and administered by the American Institute of Chemical Engineers.

On behalf of the expedition that conquered Mount Everest last year, **Brigadier Sir John Hunt** and **Sir Edmund Hillary** recently received from President Eisenhower the Hubbard Medal of the National Geographic Society. Bronze replicas of the gold original have been given to Sir John, Sir Edmund, **Tenzing Norkey** (the Sherpa guide), and the two organizations that assisted the enterprise, the Royal Geographical Society of London and the Alpine Club.

Willard Frank Libby, professor of chemistry at the Institute for Nuclear Studies, University of Chicago, is one of two Chandler medalists to be chosen this year by Columbia University. Prof. Libby was selected

for his brilliant achievements in the science of nuclear chemistry. In February he delivered the award lecture on the subject "Radiocarbon and radiohydrogen dating."

Leonard C. Mead, coordinator of research and chairman of the Department of Psychology at Tufts College, has been elected dean of the Tufts Graduate School.

Thomas Brennan Nolan, assistant director of the U.S. Geological Survey, has received Columbia University's K. C. Li Medal and the accompanying $1000 prize for his "enterprising initiative and stimulating leadership in the United States Geological Survey toward a better understanding of the geological occurrence of tungsten."

Woon Ki Paik of the Department of Biochemistry, Ewhe Medical College, Seoul, Korea, has arrived for a two-year stay at Dalhousie University, Halifax, N.S., for training and research in cell physiology under the direction of J. G. Kaplan.

A. R. Penfold, director of the Museum of Applied Arts and Sciences of Sydney, Australia, and an authority on essential oils, will receive the $1000 Fritzsche Award for 1954 at the 125th national meeting of the American Chemical Society.

The American Institute of Electrical Engineers has awarded the Edison Medal, one of engineering's top honors, to **John Findley Peters,** a Westinghouse Electric Corporation consultant, "For his contributions to the fundamentals of transformer design, his invention of the Klydonograph, his contributions to military computers and his sympathetic understanding in the training of young engineers." Mr. Peters, whose education ended with the completion of the eighth grade, worked for Westinghouse from 1905 until his retirement in 1950.

The faculty of the College of Arts and Sciences of the University of Kentucky annually selects a Distinguished Professor of the Year. This year's winner is **Herbert P. Riley,** professor and head of the Department of Botany. His acceptance lecture, on Mar. 25, will be on the subject, "The protective action of certain chemicals against the effects of ionizing radiation."

The Southern Chemist Award of the American Chemical Society's Memphis, Tenn., Section has been given to **Francis Webber Sherwood** of the Agricultural Experiment Station, North Carolina State College of Agriculture and Engineering. Dr. Sherwood was cited for his major contributions to the basic knowledge of agriculture in the South, particularly in effecting more extensive and efficient utilization of cottonseed products and peanuts by livestock, and for his production of new and improved biochemical test methods.

Tiuzi Sindo, for the past eight years distinguished member and associate professor of the Institute for Infectious Diseases of the University of Tokyo, Japan, is on the staff of National Jewish Hospital, Denver, where he is studying the serology of tuberculosis. He is also serving as visiting lecturer in microbiology at the University of Colorado School of Medicine.

Harry Sobotka was recently the guest of honor at a dinner tendered by the medical board of Mount Sinai Hospital of New York on the occasion of the completion of his 25th year as director of the chemistry laboratories at the hospital. Dr. Sobotka is also adjunct professor of organic chemistry at the Polytechnic Institute of Brooklyn.

In December, **Sir Harold Spencer-Jones,** Astronomer Royal of England and director of the Greenwich Observatory, spoke before a meeting of astronomers and members of the World Calendar Association at the American Museum-Hayden Planetarium on the subject "Is there a need for calendar revision?"

Norman Taylor has retired as director of the Cinchona Products Institute in New York, a position he has held for the last 17 years. The Institute, which has sponsored many research projects in medicine and pharmacology, is suspending its activities in the United States. All future correspondence should be addressed to Cinchona Instituut, 142 de Lairessestraat, Amsterdam—Z, Holland. Mr. Taylor's address is 20 W. 10 St., New York 11.

Education

The new **Elias P. Lyon laboratories** building at the **University of Minnesota** was dedicated recently. The structure, named in honor of the dean of the University's medical school from 1913 to 1936, was financed principally by grants from the Minnesota division of the American Cancer Society and the United States Public Health Service. The new four-story building connects two of the buildings of the present University medical center and houses laboratories for histochemistry, cancer biology, and biophysics.

The histochemistry laboratories on the first floor are devoted to the study of the nature and functions of the cell and parts of the cell with David Glick, professor of physiological chemistry, in charge. The second and third floors are devoted to cancer biology laboratories headed by John Bittner, director of cancer biology. Major research problems in this division are concerned with inherited physical traits associated with cancer. The biophysics laboratory occupies the fourth floor; here, Maurice Visscher, head of the physiology department, directs research in circulation, respiration, and metabolism.

A new laboratory, called the **High Tension Research Institute,** has been set up in Cassell, Germany, by one of West Germany's most important producers of electric goods and installations, the Allgemeine Elektrizitaets Gesellschaft. The Institute was created to aid engineers in the design of new equipment capable of handling potential differences of 400 kilovolts. West

Germany's normal 110-kv transmission systems are beginning to yield to power networks operating at 220 kv. Already a long-distance 300-kv line is in operation. Engineers predict power demands will double in 10 more years, making it necessary to resort to transmission at 400 kv.

The **Natural History Museum of Stanford University** announces that the refitting of the main fish and herpetological collection rooms is now complete. The fish collections have been supplied with 9000 sq ft of new steel shelving which will increase the fish research collection space by two-thirds. Addition of modern lighting and installation of a new electric dumb-waiter to connect the double-decked fish collection with other floors in the building, makes the Stanford collection among the best housed in the world. This valuable collection contains about 750,000 specimens and ranks only behind the great national collections in London, Paris, and Washington. It has also been possible to utilize the old shelving to renovate the herpetological collection facilities, increasing their shelf-space by 100 percent.

The entire project has cost the Museum about $30,000, nearly $28,000 of which was raised by a graduate student's Zoology Project Fund Committee headed by Giles W. Mead, John C. Briggs, and Jay M. Savage, in cooperation with George S. Myers, Curator of Zoological Collections, and Miss Margaret H. Storey, Assistant Curator.

A new 13-week **television series on archeology,** "Here is the past," is being presented by **New York University** in cooperation with WCBS-TV. The series, which commenced Feb. 20, is conducted by Casper J. Kraemer, Jr., professor of archeology and classics at the University's Washington Square College of Arts and Science. A grant-in-aid of $6500 to help prepare the series was awarded to NYU by the National Association of Educational Broadcasters through funds made available by the Educational Television and Radio Center, established by the Ford Foundation. A kinescope will be made of each program and distributed by the Center to noncommercial stations in this country and abroad.

The Yale School of Medicine and the Grace-New Haven Community Hospital, affiliated with each other since 1826, have announced an expansion of their cooperative arrangement under a new **Yale-New Haven Medical Center** plan that will be similar in concept to the Columbia-Presbyterian Medical Center in New York. Hiram Sibley has resigned as executive director of the Connecticut Hospital Association to accept the post of director of program development. A nine-member Advisory Committee on Program Development has also been appointed.

As well as the Yale School of Medicine, the new Center will embrace the Yale School of Nursing, the Yale Psychiatric Institute, the Yale Department of Public Health, and the Child Study Center. Although the emphasis of the Yale-New Haven Medical Center is not on the construction of new buildings but on the development of services already in existence, the physical plant is growing. Another hospital building, in addition to the new Grace-New Haven School of Nursing, was opened in 1953; this is the 10-story Memorial Unit, one of the most modern and best-equipped hospital buildings in the country. The Yale School of Medicine is also planning another building. Construction is scheduled to start this spring on the Edward S. Harkness Memorial Hall, a residential unit for medical students to be ready by September, 1955, and made possible by a gift of $2,750,000 from the Commonwealth Fund.

Grants and Fellowships

Establishment of a fellowship designed to produce future leaders for the mineral industries with both engineering and business administration backgrounds has been announced jointly by the **Colorado School of Mines** and the **Harvard Business School.** The two schools are cooperating in the mineral engineering fellowship program, which will enable graduates of the Colorado School of Mines to attend the Harvard Business School. A Mines graduate who is awarded the fellowship will be enrolled annually in a two-year course leading to a master's degree in business administration. He will receive a grant-in-aid of $1500 each year.

Financial support from 11 executives interested in the School of Mines made the fellowship possible. Any Mines graduate may apply for it, providing he has had at least two years' working experience in mineral engineering either before or after graduation. The initial recipient of the fellowship will be announced in September by the Harvard Business School. Others will be announced each fall. Applicants should write to the Harvard Business School, Boston 63.

Applications for grants in aid of chemical research from the **Cyrus M. Warren Fund of the American Academy of Arts and Sciences** should be received by the chairman of the committee, Edwin R. Gilliland, Massachusetts Institute of Technology, Cambridge 39, Mass., *not later than Apr. 22.* Grants are generally made for apparatus and supplies. Application blanks will be sent upon request.

During January the **Damon Runyon Memorial Fund for Cancer Research, Inc.** allocated $98,400. The following twelve grantees share this amount:

New York University Bellevue Medical Center. N. Nelson, Inst. of Industrial Medicine. Investigation of the chemical nature of environmental carcinogens, $25,000.

Sloan-Kettering Institute. C. P. Rhoads, Director. Continuation of a Damon Runyon Fund Research Ward, $10,000.

Sloan-Kettering Institute. H. L. Richardson. Histopathology of hypophysectomized animals fed carcinogens, $3900.

New York Academy of Sciences. Support of the "Fourth Cancer Research Conference of Damon Runyon Fellows," $7500.

Tufts College. F. Homburger, Medical School. Continuation of three projects, $14,000.

University of Texas. T. C. Hsu, Tissue Culture Laboratory. Chromosomes in human tumor cells, $4000.

Columbia University. E. Z. Wallace, College of Physicians and Surgeons. Renewal of grant, $3600.

Sloan-Kettering Institute. O. Miro-Quesada, Jr. Studies under C. P. Rhoads on carcinolysis with natural products of Peruvian molds, $4800.

Tufts College. D. W. Slingerland. Attendance at Medical School under E. B. Astwood, $4200.

Montreal Cancer Hospital. W. Lijinsky. Training under J. H. Quastel, $4200.

University of Minnesota. G. A. Smith. Study under O. H. Wangensteen, $5400.

Western Reserve University. E. J. Mason, Medical School. Training under T. D. Kinney on an attempt to produce destruction of hela and L strain cells in tissue culture by several animal viruses and mutants produced by x-irradiation, $4800.

Duke University has received a grant of $5000 from the National Paraplegia Foundation to establish the **Raymond C. Henyan Fellowship in Paraplegia** in honor of one of the deceased members of the California Paralyzed Veterans Association. This fellowship was made possible by a grant from the Doris Duke Foundation.

A number of graduate and advanced research fellowships are offered by the Massachusetts Institute of Technology for study and research in the field of electronics. Known as **Industrial Fellowships in Electronics**, they are sponsored jointly by a group of industrial organizations concerned with the advancement of electronics and its applications. Recipients of graduate fellowships will be awarded stipends varying between $1500 and $2400, according to their experience and qualifications, and in addition will have the tuition fee paid.

A few advanced research fellowships will be awarded to candidates possessing the Ph.D. degree or its equivalent who, without enrolling as graduate students, wish to pursue advanced studies and research in electronics; stipends range from $3000 upward.

A limited number of positions as research assistant are also available in the Research Laboratory of Electronics. Students so employed work on research projects in the Laboratory and have an opportunity to pursue a graduate program on a part-time basis. Further information can be obtained from the Director, Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Mass. *Fellowship applications should be submitted at least four months prior to the intended date of entrance.*

A nationwide competition to select winners of 50 fellowships to a special six-week **Summer Program for Science Teachers** from high and preparatory schools has been opened by the Massachusetts Institute of Technology. The winners will be at M.I.T. from June 28 to Aug. 6 to hear members of the Institute's faculty review the basic sciences of physics and chemistry and present glimpses into many new scientific frontiers. The program is an intensive series of lectures, laboratory inspection trips, and group conferences.

The fellowships in this program, which are made possible by a special grant of the Westinghouse Educational Foundation, will be awarded to experienced science teachers throughout the United States and Canada who hold college degrees or who have had equivalent training and background. *Applications are due before Apr. 1,* on blanks which may be obtained from the M.I.T. Summer Session Office, Room 7-103, Cambridge 39.

Meetings and Elections

The program of the first annual meeting of the **Academy of Psychosomatic Medicine,** to be held in New York City, Oct. 8–9, will be devoted to "Psychosomatic aspects of surgery." There will be contributed and invited papers on such topics as: psychosomatic aspects of anesthesia, general surgery, gynecological surgery, plastic, otolaryngological and oral surgery, mutilating operations, endoscopic surgery, orthopedic surgery, eye surgery, pediatric and geriatric surgery, and neurological surgery. Those who are interested in presenting papers should write to Dr. B. B. Raginsky, 376 Redfern Ave., Montreal, Canada, stating their special interest.

Those who wish to apply for fellowships and associateships in the Academy of Psychosomatic Medicine should address Dr. Ethan Allan Brown, Secretary, 75 Bay State Road, Boston 15, Mass. New fellows will be inducted into the Academy at the October meeting in New York, at which time certificates of membership will be presented.

The 27th annual meeting of the **American Association of the History of Medicine** will be held in New Haven, Conn., May 6–8. The Hotel Taft will serve as headquarters. Lloyd G. Stevenson, head of the Department of Medical History and Literature at the University of Western Ontario, Faculty of Medicine, 346 South St., London, Canada, is chairman of the Program and Arrangements Committee. Besides the usual dinner session, there are plans in the making for symposia on the history of medical statistics, on the interrelations of chemistry and medicine, and on the historical impact of curative medicine on society. In addition, there will be general sessions covering the usual range of subjects dealing with medical history and the humanities.

A joint meeting of the Radio Technical Commission for Aeronautics, The Franklin Institute Laboratories, and the Philadelphia sections of the Institute of Aeronautical Sciences and the Institute of Radio Engineers (Professional Group on Aeronautical and Navigational Electronics) will be held at The Franklin Institute in Philadelphia on Apr. 22–23. **"Aviation and electronics look ahead"** will be the theme.

The number of scientists interested in the investigation of problems concerning the social insects, and the variety of interests among these individuals, has increased sufficiently to create a demand for an international organization to coordinate efforts and facilitate the study of such problems. After a preliminary meeting at the 1951 International Congress of Entomology in Amsterdam, the organization of national branches proceeded in France, Germany, Italy, the United States and other countries. The **International**

Union for the Study of Social Insects, through which these branches are now associated, has its office in Paris, 105 Boulevard Raspail, at the laboratory of Dr. Pierre-P. Grassé, who is president of the international organization.

The principal objective of the International Union is to encourage the study of problems concerning the social insects, including all phases of their biology, ecology, taxonomy, and behavior, and to facilitate the exchange of evidence and ideas in this general field through conferences and appropriate publications. The organization will thus foster communication within a large and heterogeneous international body of scientists interested in the social insects and related forms. Previously, articles published on subjects cognate to the social insects have been scattered through a considerable number of highly diversified journals, and integration has been correspondingly limited among the interested investigators and students themselves.

An introductory *Bulletin* of three numbers was published in France during 1953 and issued to members through the Paris office. Beginning in 1954 an illustrated journal of 320 pages entitled *Insectes Sociaux* will be published by Masson and issued in an annual volume of quarterly numbers. Subscriptions may be arranged through Stechert-Hafner, 31 East 10 Street, New York.

Two international symposia on the social insects have been sponsored by this organization and a third one is to be held in conjunction with the next International Congress of Entomology. The North American branch sponsored symposia at the meetings of the Entomological Society of America in Philadelphia in 1952 and in Los Angeles in 1953, and further ones will be held. Comparable conferences are organized periodically by the other national branches. Those who are seriously interested in the scientific study of problems pertaining to the social insects may apply to the secretary of the North American branch, Dr. Robert E. Gregg, Department of Zoology, University of Colorado, Boulder, Colorado, for membership application blanks. Members of the organization, in consideration of a modest annual dues payment, receive the "Notes and News" section of the journal. The North American branch invites the interest of prospective members in Canada, Central America, Mexico, and the United States.

Science teachers from elementary schools, high schools, and colleges will meet in Chicago, Apr. 1–3, to discuss how to cope with an increasing school population and a growing shortage of qualified science teachers. The discussions will be held during the second national convention of the **National Science Teachers Association**, a department of the National Education Association.

The first annual meeting of the **New England Section of the Association of Geology Teachers** will be held at the University of Vermont, Apr. 2–3. The technical sessions will consist of papers and discussions on the practical side of teaching, laboratory, demonstrations, and field trips. The program will include a field trip to student localities in the immediate vicinity of the University. Nonmembers are invited.

Fifteen hundred analytical chemists from all parts of the United States will convene in Pittsburgh on Mar. 1 for the fifth annual **Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy.** Sponsored jointly by the Analytical Chemistry Group of the American Chemical Society's Pittsburgh Section and the Spectroscopy Society of Pittsburgh, the five-day conference will be held in the Hotel William Penn.

New techniques for assaying uranium, recent methods of controlling lubricating oil additives, and testing procedures for newly developed alloys are some of the contributions of analytical chemistry and spectroscopy to be reported in a total of 122 technical papers by chemists and spectroscopists from university, government, and industrial laboratories throughout the country.

The Society of Women Engineers will hold its 1954 annual convention at the Mayflower Hotel in Washing, D.C., on Mar. 6–7.

Miscellaneous

The American Eugenics Society, Inc., has announced that the first issue of its new journal, the ***Eugenics Quarterly***, will appear in March. This publication is the successor to the organziation's *Eugenical News*.

A unique collection of **medical art** by such masters as Rembrandt, Goya, Daumier, Vesalius, Toulouse-Lautrec, and others is being shown at medical colleges and hospitals across the country during a tour that was launched in February. The collection, entitled "Ars Medica," consists of 85 prints depicting the practice of medicine up through the centuries. It was assembled by the Philadelphia Museum of Art through the support of Smith, Kline & French Laboratories.

Technion, Israel Institute of Technology, in Haifa, Israel, has just announced openings for several professors in various departments. Technion has expanded greatly during recent years, and the existing staff must be enlarged by adding the best available personnel. Candidates must possess not only high professional and academic qualifications but also confidence in the progress of Israel.

The Institute will pay transportation costs for personnel and their families and all reasonable expenses for the shipment of personal effects to Israel. Technion will see to it that they get proper housing and in every other way will assist them in the process of settling in their new surroundings. Assistance will be given in such matters as dealing with government offices, schools, and language. It should be noted that the language of instruction at Technion is Hebrew. Present knowledge of the language is useful though not a requisite. However, a new staff member will be

expected to learn the language and in due course to teach in it.

Applications are invited for full professors in the following departments: structural engineering; hydraulic engineering; mechanical engineering; mathematics; physical chemistry; geology; and mechanics (with special qualifications in general mechanics and oscillations). Applications with full particulars should be sent, *until Mar. 31,* to the Secretary for Academic Staff, Technion, Haifa, Israel. For further details, write to the Technical Director, American Technion Society, 1000 Fifth Ave., New York 28.

Social workers, dietitians, biochemists, x-ray and medical technicians, and therapists of all types are urgently needed to fill immediate vacancies in **Veterans Administration hospitals** throughout the country. Qualified applicants should contact the personnel office at any VA hospital, regional office, center, or domiciliary for information regarding vacancies and qualification requirements; or write directly to the Veterans Administration, Washington 25, D.C.

Necrology

Edwin H. Armstrong, 63, inventor and professor of electrical engineering at Columbia University, New York, N.Y., Jan. 31; **G. Mason Astley,** 71, emeritus professor of surgery at the Temple University School of Medicine, Philadelphia, Pa., Jan. 15; **Charles Berkowitz,** assistant professor of clinical medicine at the Chicago Medical School, Chicago, Ill., Jan. 11; **Leonard E. Dickson,** 79, author and professor emeritus of mathematics at the University of Chicago, Chicago, Ill., Jan. 17; **Ernest Esclangon,** 78, inventor, astronomer, and former director of the Paris Observatory, Paris, France, Jan. 28; **Francis E. Fox,** 44, author, professor of physics, and acting dean of the School of Engineering and Architecture at the Catholic University of America, Washington, D.C., Dec. 29; **Edward M. Freeman,** 78, plant pathologist, author, and dean emeritus of the Minnesota College of Agriculture, St. Paul, Minn., Feb. 5; **Paul H. Geiger,** 57, research physicist for the Engineering Research Institute at the University of Michigan, Ann Arbor, Mich., Jan. 27; **Lex B. Golden,** 38, head of the corrosion unit of the U.S. Bureau of Mines at the University of Maryland, College Park, Md., Jan. 25.

Joseph E. Hirsh, 74, retired chief research chemist for the Sun Chemical Company, Long Island City, N.Y., Jan. 23; **Karl J. Holzinger,** 61, author, editor, and professor of educational statistics at the University of Chicago, Chicago, Ill., Jan. 15; **Edwin A. Johnson,** 61, retired electronic scientist of the Naval Research Laboratory, Washington, D.C., Jan. 14; **Paul B. Johnson,** 75, former professor of anatomy at Georgetown University Medical School, Washington, D.C., Jan. 16; **Roger A. Johnson,** 64, author, and retired chairman of the Department of Mathematics at Brooklyn College, New York, N.Y., Feb. 9; **George H. Kress,** 79, former dean of the University of California School of Medicine at Los Angeles, Calif., Jan. 18; **Gino Loria,** 92, mathematician, Genoa, Italy, Jan. 30; **Harald Lundin,** 60, chemical research engineer and authority on deposition of metals, West New York, N.J., Jan. 19.

Karl B. McEachron, 64, lightning research engineer for the General Electric Co., Pittsfield, Mass., Jan. 24; **James S. McLester,** 77, nutrition expert, author, former president of the American Medical Association, and professor emeritus of medicine at the University of Alabama, Birmingham, Ala., Feb. 7; **Colin M. Mackall,** 69, professor emeritus of chemistry at the George Washington University, Washington, D.C., Jan. 26; **Milton K. Meyers,** 72, neurologist, psychiatrist, and author, Philadelphia, Pa., Jan. 25; **Henry F. Moore,** 66, author and head of cortisone research in Ireland, Dublin, Ireland, Jan. 25; **Samuel B. Moore,** 74, former associate professor of medicine at New York Medical College, New York, N.Y., Jan. 17; **David M. Myers,** 75, consulting engineer, author, and inventor, Larchmont, N.Y., Jan. 20; **Harold H. Nelson,** 75, Egyptologist, author, professor emeritus and former director of the Oriental Institute, University of Chicago, Chicago, Ill., Jan. 24; **John D. Northrop,** 67, chief of the Mineral Classification Branch, Conservation Division, U.S. Geological Survey, Washington, D.C., Jan. 31; **Howard A. Poillon,** 74, president emeritus of the Research Corporation, New York, N.Y., Jan. 19; **Horace H. Raymond,** 56, inventor and research engineer in the Ordnance Department, National Bureau of Standards, Washington, D.C., Jan. 23; **Leo B. Roberts,** 66, explorer, topographer, and civil engineer, Port Washington, N.Y., Jan. 16; **Harold W. Rogers,** 71, retired research engineer of the General Electric Co., Jan. 21.

Robert F. Smith, 87, retired associate professor of mathematics at City College, New York, N.Y., Jan. 31; **John L. Sperry,** 60, lepidopterist, Riverside, Calif., Jan. 21; **Norma C. Styron,** 56, research microbiologist and instructor at the New York University College of Medicine, New York, N.Y., Jan. 23; **Curtis L. Weathers,** 56, professor and chairman of the Department of Biology at Long Island University, Brooklyn, N.Y., Feb. 8; **Alfred C. Weed,** 73, ichthyologist and former Curator of Fishes at the Museum of Natural History, Chicago, Ill., Nov. 30; **Francis P. Wells,** 46, retired physician and bacteriologist of the Army Medical Corps, Arlington, Va., Feb. 7; **Frank Wenner,** 81, consulting physicist, seismologist, and retired chief of the Resistance Measurement Section, Electric Division, National Bureau of Standards, Washington, D.C., Feb. 7; **Rollin T. Woodyatt,** 74, diabetes research, author, and former professor of medicine and chemistry at the Rush Medical College, University of Chicago, Chicago, Ill., Dec. 17; **Calvert C. Wright,** 48 professor and chief of the Division of Fuel Technology at the Pennsylvania State University, State College, Pa., Feb. 1; **Lewis E. Young,** 75, former president of the American Institute of Mining and Metallurgical Engineers, Pittsburgh, Pa., Dec. 27.

Technical Papers

Physiological Damage under Emotional Stress as a Function of Early Experience[1]

Otto Weininger[2]

Department of Psychology,
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Studies at the Wistar Institute of Anatomy and Biology at Philadelphia (*1*) have suggested that the more that albino rats are handled and petted, the better they seem to thrive in the laboratory situation. Major hypotheses investigated in the present study were that albino rats, gentled for 3 wk for 10 min a day following weaning, would (a) show significantly greater mean weight, (b) show more activity and less fearful behavior in an open field situation, and (c) sustain less physiological damage to the endocrine, cardiovascular, and gastrointestinal systems under prolonged emotional stress as adults, than would a comparable group of controls.

Three litters of male albino rats, pure Wistar strain, were randomly sorted by litters into two groups immediately following weaning (23 days of age), and were housed in individual cages. A check on randomness of this procedure showed the mean weights of these two groups to be approximately the same. The 16 male animals in the experimental group were gentled for 10 min a day for the next 21 days. Gentling consisted of holding the animal in the experimenter's left hand with the hand placed against the experimenter's chest, so that the animal was nestled in the palm of the left hand, with the right thumb or forefingers stroking the back of the animal from the head to the base of the tail. During this time the control group of 16 male albinos was not handled at all, but in all other respects was treated exactly the same as the experimental group. Water and Fox Bar food pellets were available to all animals in both groups ad libitum.

At 44 days of age, that is, 3 wk after weaning, rats in both groups were weighed, and were weighed once a week thereafter. The animals were introduced to a brilliantly lighted open field situation at the ages of 58 and 65 days. At 60 days of age rectal temperature was taken, and finally, at 79 days of age each rat was immobilized and placed on its back for a period of 48 hr during which time it was deprived of food and water. At the end of the stress period, the animals were sacrificed and autopsies were performed by an independent laboratory technician who had no means of identifying the group to which the animals belonged.

Inspection of the data indicates support for all three major hypotheses. In respect to weight, for example, a check at 44 days showed the mean weight of the gentled group to be 161.06 g compared to 141.25 for the nongentled, a different significant at the 0.0002 level of confidence, although there had been no significant difference between the weights of these two groups at the start of the experiment, when the animals were 23 days of age. This trend continued throughout the experiment. At 79 days of age, just before introduction of the stress situation, mean weight of the gentled group was 319.00 g, compared to 264.75 for the nongentled. Critical ratio obtained here was 13.3. Further analysis indicated that this difference in weight between experimental and control groups was related to a significantly greater proportion of adipose tissue per 100 g of body weight for the former, and to a significantly greater skeletal length for the former. The gentled rats simply grew more than the nongentled.

Records of activity in the open-field test did not turn out in the direction predicted by the second hypothesis. In the first trial, the nongentled animals wandered over the grid to a greater extent than the gentled; in the second trial, no significant difference was obtained. But in both trials, the gentled rats ventured significantly closer to the brilliantly lighted center of the open-field setup, thus showing more of a tendency to ignore the natural habit of their species to cling to walls (thigmotaxis) and avoid light. Rectal temperatures were significantly greater for the gentled rats, which suggests that the basal metabolic rate of the experimental animals may have been altered by the gentling procedure.

Finally, autopsies of the 32 rats immediately following stress showed that relatively more damage had been sustained by the cardiovascular and gastrointestinal systems of the nongentled animals compared to the gentled. Results for the endocrine system were equivocal. In respect to the heart, examination showed that 12 out of 16 rats in the nongentled group, but only 5 out of 16 in the gentled group, had suffered severe heart damage, including distension of the surface blood vessels. This difference is acceptable at the 2% level of confidence. No statistically significant difference with respect to liver and kidney damage was observed. In regard to the gastrointestinal system, a count showed a total of 54 bleeding points in the stomach and duodenum of the nongentled rats and a total of 9 for the gentled. This difference is significant at the 0.01 level of confidence. In terms of weight per 100 g of body weight, the adrenals of the nongentled animals were significantly heavier, at the 0.001 level of confidence, than the adrenals of the gentled animals. No significant differences in weight were obtained in respect to kidneys, liver, or pancreas glands.

Cardiovascular damage under prolonged stress, as Selye has shown (*2*), may be considered an end product of the action of ACTH from the pituitary in re-

[1] This article is, in substance, the same as a paper delivered Dec. 28, 1953, at the annual meeting of the AAAS in Boston.

[2] This research was supported by a grant from the National Research Council of Canada, to Dr. E. W. Bovard, Jr.

leasing hormones from the adrenal cortex. The relative immunity to stress damage on the part of the gentled animals may, therefore, have resulted from a decreased ACTH output from the pituitary in response to the same alarming situation that also faced the nongentled animals. If this were the case, it could be expected that a comparison of adrenals from gentled and nongentled rats following stress would show the latter to be heavier, after being stimulated by more ACTH output. Such was indeed the case.

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The Energy Requirements for Bacterial Motility

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In light of recent advances on the structure of bacterial flagella (*1, 2*), it is of interest to calculate the energy expended by these "monomolecular muscles" in propelling the organism.

For the case of a small object moving through a viscous medium at low velocity, the force F necessary to balance frictional resistance is given by $F = fv$, where f is the frictional coefficient and v the velocity. If the bacteria under consideration are assumed to be prolate spheroids of equatorial semi-axis b and semi-axis of revolution a, then f, is given (*3*) by

$$f = \frac{6\pi\eta \int^{\beta} \sqrt{ab^2(1-\rho^2)^{1/2}}}{\rho^{2/3} \ln\left[\frac{1+(1-\rho^2)^{1/2}}{\rho}\right]}, \qquad (1)$$

where η is the coefficient of viscosity of the medium surrounding the bacterium and ρ is the ratio of axes, b/a. The energy expended per unit time, P, is given by

$$P = Fv = fv^2, \qquad (2)$$

where f is given by Eq. (1).

This formulation neglects the frictional resistance of the flagella which will be assumed to have the same value of that of the bacterium for order of magnitude calculations. An extension of the more exact hydrodynamical analysis of Taylor (*4*) should lead to a more precise value of P.

For cells of *Bacillus subtilis*, b is 0.5 micron, a is 1 micron (*5*) and v is 10 microns/sec (*6*). The coefficient of viscosity of water at 25° C is approximately 0.009 poise. Substitution of these values in Eq. (2) leads to a value of about 1.1×10^{-11} erg/sec. Doubling this figure to allow for the resistance of the flagella and converting to more convenient units yields a power output in motility of about 14 electron volts/sec. Further assuming that the conversion from chemical to mechanical energy is 25 percent efficient, one finds the total rates of energy expenditure for motility of one organism to be about 56 electron volts/sec.

The analogy between flagella and muscle fibers (1), and the observation that isolated flagella contract in the presence of adenosine triphosphate (2) makes it reasonable to assume that the energy of motility comes from energy rich phosphate bonds. In that case about 150 bonds reacting per sec would supply the necessary energy. Electron micrographs indicate that the organism has about 10 to 20 flagella, and analogous data from the flagella of larger organisms would indicate that each of the flagella flicks about 10 to 20 cps.

As the total number of flagellar flicks per sec, 100–400, is the same order of magnitude as the number of bonds reacting per sec, it is possible to consider each flagellar flick as the result of a small number of discrete chemical events (perhaps one), such as metabolic hydrolysis of energy rich phosphate bonds. In studying bacteria, one reaches a small order of size where a very few reacting molecules exert a large influence.

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The Induction of Scab Lesions on Aseptic Potato Tubers Cultured *in vitro*[1]

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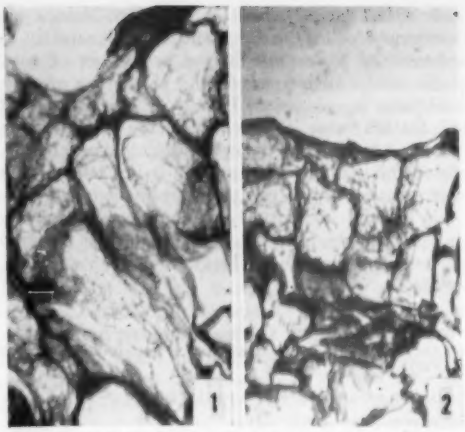
The production *in vitro* of tubers from etiolated potato shoots has been reported recently (*1*). It was considered that a significant contribution could be made concerning the inception of potato scab lesions by observing the action of a pure culture of a known pathogenic strain of *Streptomyces scabies* (Thaxter) Waks. and Henrici on sterile potato tissue. This would be of particular interest because it has not been possible to demonstrate that *S. scabies* alone could cause scab. In addition, there are reports citing the habitation of normal potato tissue by microorganisms (*2–4,* among others). It is with these considerations that this preliminary report is concerned.

A series of differential media was used in an attempt to isolate microorganisms that might be occurring as "normal" microflora of the cultured potato tissue. In addition, the medium used in culturing the potato tissue (*1*) will support the growth of many organisms. In no case was there a microorganism isolated from cultured potato tissue which appeared

[1] Supported in part by the Potato Scab Committee of Ontario.

[1] Present address: National Heart Institute, National Institutes of Health, Bethesda, Md.



FIGS. 1 and 2. Intracellular strands of *Streptomyces scabies* in tissues of cultured Katahdin tubers (×300).

sterile at the time of tuber formation, while examination of histological preparations failed to reveal any colonization. It is realized, nonetheless, that some bacterial or fungal organism could exist which has eluded all the attempts at isolation but it is considered that the possibility of this is remote and that the cultured potato tubers were sterile. The successful culturing of aseptic tuber callus by Steward and Caplin (*5*) supports this contention.

A known pathogenic strain of *S. scabies*, isolate P 21,[2] was used in all experiments. Although several inoculation technics were used, a loop transfer of *S. scabies* in sterile distilled water applied to the aseptic unwounded surface of an aerial tuber proved to be the most satisfactory. In addition, it was found that a scab lesion could be induced most readily by applying the inoculum to a tuber surface in contact with the wall of the culture vial. Apparently, under such conditions, moisture persisted long enough for infection to occur.

Common scab lesions appeared on rapidly enlarging Katahdin tubers within 10 days of inoculation and only at the site of the inoculation. Tubers, each bearing a well-developed lesion, subsequently were transferred to Difco potato dextrose agar in Petri plates. After a period of incubation pure cultures of *S. scabies* agreeing in morphological characteristics with isolate P 21 were obtained. Reinoculations were made on suitable aseptic tubers using isolates recovered as outlined above and once again scab lesions appeared at the point of inoculation. Isolates yielded only *S. scabies* which was similar in appearance to the isolate P 21 as originally used. There was no evidence of bacterial or fungal contaminants. After two passages alternately through P.D.A. and host tissue the isolates of *S. scabies* still resembled control colonies and still were pathogenic.

Tubers with scab lesions were fixed in Navashin's Craf, sectioned at 10 μ, and stained with safranin-fast green. Microscopic examination of scab lesions revealed the presence of intracellular filaments of *S. scabies* (Figs. 1 and 2); this is in agreement with the illustrations of Hooker *et al.* (*6*). *S. scabies* was associated only with macroscopically apparent lesions. Filaments of isolate P 21 in agar stained as above agreed with those in infected host tissue. In addition P.D.A. blocks infested with *S. scabies* and applied to the sterile surface of a tuber showed contiguous filaments in the agar and in the tuber.

In recapitulation, shallow common scab lesions have been induced by inoculation of unwounded aseptic potato tubers with a pure culture of a known pathogenic strain of *S. scabies*. The causal organism after successive passages through the host, resulting in lesion formation, and subsequent recoveries in pure culture showed no apparent attenuation of pathogenicity. The subcultures were similar to control cultures of *S. scabies*, isolate P 21. As none of the methods attempted revealed the presence of any microorganism in the cultured host tissue it may be assumed that the scab lesions were incited by the *S. scabies*.

Of practical importance is the fact that by this technic a scab lesion can be obtained on a tuber within one month of the culturing of a node of an etiolated potato shoot. The possibilities that such rapidity of tuber production can be of benefit to the testing of scab resistant varieties are included in current investigations.

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[2] The Department of Bacteriology, Ontario Agricultural College, supplied the cultured *S. scabies*, isolate P 21 and also assisted in the assessment of the sterility of the potato tissue. This is gratefully acknowledged.

Effect of Benzothiazol-2-Oxyacetic Acid in Delaying Maturity of Grapes

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During the testing of various growth regulators on grapes at Davis, California, it was found in 1953 that benzothiazol-2-oxyacetic acid strikingly retarded the maturity of several varieties. As a delay in ripening and harvesting would be of commercial interest in some regions, results of these preliminary tests are reported. These results should also be of interest to plant physiologists in general and to chemists interested in the synthesis and uses of such compounds.

Red Malaga, Tokay, Ribier, Zinfandel, and Thompson Seedless in their fourth or fifth summer of growth

TABLE 1. Effect of benzothiazol-2-oxyacetic acid on development of Red Malaga and Thompson Seedless grapes.

Concentration (ppm)	Date of treatment	Av. wt./berry (g)	Total soluble solids (%)	Acid (%)	Color (%)
		Red Malaga			
0	—	3.89	21.3	0.46	98
50	June 29	3.45	17.5	.66	50
50	July 31	3.19	14.9	.90	30
		Thompson Seedless			
0	—	1.31	22.8	.56	—
20	June 10	1.70	18.2	.70	—
50	June 10	1.32	19.4	.69	—
100	June 10	1.28	17.2	.68	—
0	August 10	—	21.1	.59	—
20	August 10	—	19.2	.72	—
50	August 10	—	18.9	.70	—

were used. All are varieties of *Vitis vinifera*, and all are seeded except Thompson Seedless. The clusters of Thompson Seedless sprayed on June 10 were reduced to 6 per cane one day before time of treatment, but vines sprayed on Aug. 10 were not thinned (*1*). Tokay was berry-thinned and Ribier flower-cluster thinned so that there were about 12 clusters per vine. Red Malaga and Zinfandel were not thinned.

Benzothiazol-2-oxyacetic acid (obtained from the American Cyanamid Co.) was dissolved by adding sufficient ammonia to an aqueous suspension of the compound. Dreft, about 0.2% by weight, was used for a wetting agent. The sprays were applied with a 3-gal hand-sprayer. The clusters and much foliage were heavily sprayed. There were 2 vines per treatment, except for the spraying of Thompson Seedless on Aug. 10 when there were 5.

Each variety was first sprayed soon after the shatter of berries following flowering. When a second lot of vines was sprayed, berries of Red Malaga and Zinfandel were beginning to color, but berries of Tokay and Ribier were still green although they had attained almost maximum size. Thompson Seedless on Aug. 10 had about 12% total soluble solids.

There was little or no damage to foliage except from the spraying of Thompson Seedless on June 10. By Aug. 10 many of these leaves, especially on the apical one foot of shoots sprayed with compound at 20 ppm, were cupped and crumpled. The injury was progressively greater with applications of compound at 50 or 100 ppm.

Thompson Seedless grapes sprayed on Aug. 10 were harvested on Sept. 1, and all other grapes were harvested on Sept. 23 (Table 1). About 30 lb of fruit were harvested per treatment. The procedure for determining average weight per berry, percentage of total soluble solids, and percentage of acid has been described previously (*2*). The percentage of the total surface of fruit that was colored was estimated.

The data (Table 1) show that with Red Malaga and Thompson Seedless the compound delayed maturity, as evidenced by a decrease in the percentage of total soluble solids, an increase in the percentage of acid, or decrease in coloration. Results similar to those of Red Malaga were obtained with the other grapes studied. Although the growth regulator usually decreased the size of seeded grapes, it is probable that lower concentrations or later applications of compound would delay maturity without decreasing berry size. The compound at 20 ppm sprayed on June 10 increased the size of the berry of Thompson Seedless (*2*).

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Ephelis on *Sorghum halepense* in Mysore

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Severe infection of *Sorghum halepense* (Linn.) Pers. incited by a species of *Ephelis* was noticed in a field in Mysore, India. As many as 40% of the plants were infected in restricted areas, the diseased plants being conspicuous by their malformed, mummified inflorescence bearing grayish-white pseudomorph of the fungus. In healthy plants the inflorescence is a loose

FIG. 1. Healthy and diseased spikelets of *Sorghum halepense*.

panicle, whereas in the diseased plants the spikelets become bound into a cylindrical structure 3–6 in. long, covered with the sclerotioid masses of the fungus (Fig. 1). Individual spikelets and glume of diseased inflorescence were uniformly dwarfed, as compared with healthy ones, and ultimately failed to develop grains. Diseased plants could be detected in early stages before development of inflorescence by the silvery white films of fungus growth covering the upper leaf surface.

The fungus incited systemic infection of plants and developed ephelidial fructifications in exciples which measured 300–500 μ in diameter. The conidiophores are simple or branched, bearing numerous acicular hyaline conidia that measured 13–23 × 1–1.5 μ with a mean of 18 × 1.2 μ. When diseased spikelets were mounted in water, large masses of conidia loosened from the exciple were released into the water.

Ephelis and *Balansia* stages have been reported from India on several grass hosts, but none so far has been reported on *Sorghum halepense*. An *Ephelis* stage on *Sorghum vulgare* was described by Bruner (*1*) from Cuba and this has been shown by Diehl (*2*) to be the conidial stage of *Balansia claviceps* Speg. The ephelidial conidia of *B. claviceps* measure 24–40 × 1–1.5 μ; while those of *Ephelis* on *S. halepense* measure 13–23 × 1–1.5 μ and therefore belong to a separate species. A detailed description of the fungus based on cultural and inoculation studies is being published separately.

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Manuscript received May 4, 1953.

The Relation of Allergy Reagins to Electrophoretic Components of Serum[1]

Dan H. Campbell, John R. Cann,[2] Townsend B. Friedman,[3] and Raymond Brown[4]

Gates and Crellin Laboratories of Chemistry, California Institute of Technology, Pasadena

Several years ago we published a preliminary report on the fractionation of serum from egg-sensitive patients by the electrophoresis-convection method (*1*). These preliminary data indicated that circulating antibody capable of giving Prausnitz-Kustner reactions might occur in serum components other than gamma globulin. Since then, these observations have been confirmed by other investigators (*2, 3*), as well as our subsequent studies which are reported here. All fractions were tested for their ability to sensitize normal skin passively and to combine specifically with ovalbumin as described by Miller and Campbell (*4*).

[1] This work was supported in part by the Public Health Service and in part by the Rockefeller Foundation.

[2] Present address: University of Colorado, Department of Medicine, Denver.

[3] 104 South Michigan Ave., Chicago, Ill.

[4] Lederle Laboratories, Pearl River, N. Y.

Methods

Fractionation of serum. The electrophoresis-convection fractionation of serum was carried out in essentially the same manner as described by Cann, Brown, and Kirkwood (*5*). Two 70-ml samples of whole serum were each diluted to 120 ml and run simultaneously in two separate units. Identical fractions were combined in order to supply sufficient material for the different analyses. Fractionation was carried out in phosphate buffer at pH 7.0 and an ionic strength of 0.1. The field strength was about 1.5 v/cm and the time of each run was about 48 hr. The material present in the top portion of the cell after the first run was labeled T-1 and set aside for testing. The material in the bottom portion of the cell was refractionated and the resulting fractions designated as T-2 and B-2. The B-2 fraction was further separated into albumin and globulin fractions by one-half saturation of the solution with ammonium sulfate at pH 7.8.

Characterization of fractions. The electrophoretic components of each fraction were determined in the usual manner using barbital buffer at pH 8.4. Mobilities were calculated in accordance with the suggestions of Longsworth and MacInnes (*6*). The apparent relative concentrations of electrophoretic components were determined by finding the ratio of the component area in descending patterns to the total area, exclusive of the ε boundary. The areas were measured on projected tracings of the descending patterns with a planimeter. Although both gamma and beta components usually resolved into two fractions (γ_1, γ_2, β_1, β_2), this detail did not seem to be of sufficient significance to record this separation in Table 1. The usual designations of albumin, α_1, α_2, β, and γ, were given to components having mobilities in the range of 6.0, 5.0, 4.0, 3.0, and 1.0, respectively.

Serological properties. All fractions were tested for their specific affinity for ovalbumin by methods described by Miller and Campbell (*4*). This value is expressed as the percent of the fraction that apparently combined with ovalbumin and was brought down as additional protein nitrogen upon addition of a standard amount of rabbit antiovalbumin serum. The amount of the respective fraction which was added to the standard precipitating system was always 7.0 mg. Protein analysis of precipitates was made in the usual manner using the Nessler reaction as described by Lanni and Campbell (*7*).

Analysis for reaginic activity. The protein concentration of various fractions was determined and then adjusted to a value of 7.0 mg per ml and sterilized by filtration. Varying dilutions in 0.1-ml amounts were then injected intradermally into normal volunteers. Forty-eight hours later the prepared sites as well as control sites were tested with intradermal injections of antigen. The reaginic activity was expressed as the limiting dilution of the 0.7 percent protein solution which produced a definite passive transfer reaction.

TABLE 1. Some properties of reaginic serum protein fractions. Distribution of electrophoretic components percentage of fraction).

Fraction	Albumin	α_1	α_2	β	γ	Percent SAP	PK titer
			F-1 *Egg sensitivity only*				
Serum	65	6	6	9	14	0.6	Undiluted
T-1	8	0	0	12	80	1.8	"
T-2	12	0	8	20	60	14.2	1: 10
BG-2	1	26	29	43	1	27.0	1: 160
BA-2	85	14	0	8	0	0.0	Negative
			F-2 *Multiple sensitivity including egg. Ragweed and egg antigens gave the same test reaction*				
Serum	65	2	12	10	11	3.0	1: 10
T-1	8	0	0	24	68	0.0	Undiluted
T-2	10	0	8	29	53	5.3	1: 20
BG-2	18	10	52	11	9	2.7	1: 20
BA-2	84	8	4	4	0	0.0	Undiluted
			M-1 *Egg sensitivity only*				
Serum	61	5	8	14	12	0.0	Undiluted
T-1	7	0	4	16	73	0.0	Negative
T-2	11	0	4	28	62	0.0	"
BG-2	27	7	47	15	4	0.0	1: 20
BA-2	88	6	2	4	0	0.0	Negative
			S-1 *Ragweed sensitivity only*				
Serum	66	3	11	9	11	0.0	Undiluted
T-1	0	0	5	10	85	0.0	Negative
T-2	0	0	5	18	77	0.0	"
T-3	4	2	7	20	68	0.0	"
BG-3	34	9	38	16	3	0.8	1: 40
BA-3	83	8	8	0	0	0.0	Undiluted
			F-3 *Multiple sensitivity, but no egg. Tested with cottonseed*				
Serum	65	5	12	8	10	0.0	1: 10
T-1	7	0	0	13	80	0.0	1: 10
T-2	13	4	8	14	61	0.0	1: 20
BG-2	18	10	52	11	9	0.0	1: 20
BA-2	84	8	4	4	0	0.0	Undiluted
			F-4 *Multiple sensitivity but no egg. Tested with ragweed*				
Serum	59	6	10	14	11	0.0	1: 10
T-1	7	0	0	16	77	0.0	1: 10
T-2	14	0	11	21	54	0.0	1: 40
BG-2	11	7	58	17	7	0.0	1: 80
BA-2	84	8	3	5	0	0.0	Undiluted
			F-5 *Ragweed sensitivity only*				
Serum	49	6	9	21	15	0.0	1: 10
T-1	0	0	0	23	77	0.0	Negative
T-2	0	0	0	26	74	0.0	Undiluted
BG-2	8	7	38	34	13	0.0	1: 20
BA-2	81	11	0	8	0	0.0	Undiluted

Note:
SAP = Specific absorbable protein: The percent of the fraction (7.0 mg) which combined with ovalbumin and was precipitated upon addition of standardized rabbit antiovalbumin serum.
PK titer = based on limiting dilution of 0.1 ml of an 0.7% solution.
T = top. B = bottom. G = globulin. A = albumin.

The PK titer given in Table 1 represents an average value obtained by tests on four different individuals.

RESULTS

The pertinent experimental data are given in Table 1. The nature of tests involved does not afford a precise quantitative evaluation of the data presented. However, it is clearly evident that reagins are not characteristically associated with the gamma globulin component of serum. In most instances analytical data are not precise enough to make any definite conclusions as to what component or components contain

activity. However, in the case of serum S-1 it would appear as though the activity resided almost entirely in the α_2 component. It was also of interest that this preparation contained some material that combined with ovalbumin although the patient failed to show any clinical history of egg sensitivity. Some of the fractions were tested for diphtheria antitoxin activity, typhoid agglutinins, and blood group specific antibodies. The antitoxin and typhoid agglutinins were always present when gamma globulin predominated and the blood group agglutinins were always strongest in the T-2 fractions, as would be expected from previous work. Of the four patients not sensitive to egg white, only one produced a serum fraction which combined with ovalbumin (the BG-2 fraction of S-1 serum). All the M-1 serum fractions failed to combine with ovalbumin, but it was later found that this individual was sensitive only to the ovomucin component of egg white. Although some of the apparent discrepancies in the relation of PK titers to the relative concentration of serum components may be the result of error inherent in the method of titration, there is also a possibility that inhibiting substances may occur in serum. Since these serums all came from individuals who had no previous history of treatment, one would not expect to find classical "neutralizing" antibodies to be present.

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The Effect of Carbonic Anhydrase Inhibition on the Composition of Urine and Plasma of the Alligator

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The administration of a potent carbonic anhydrase inhibitor (6063 or Diamox 2-acetylamino-1,3,4-thiadiazole-5-sulfonamide)[1] causes a marked increase in excretion of Na, K, water, and bicarbonate, a decrease in titratable acidity, and an increase in urine pH in the dog, man, rat, and freshwater catfish (*1–3*). According to modern theory, carbonic anhydrase seems to be essential in mammals for acid secretion by the renal tubules, the H ions competing with Na and K for excretion (*4*). Carbonic anhydrase enables these animals to produce an acid urine and so conserve base.

The electrolytes normally present in the plasma of the alligator (*A. mississippiensis*) (*5*) occur in approximately the same concentrations as those of the human yet the composition of alligator urine is quite dissimilar to that of mammals. Although the major share of the urinary nitrogen is excreted in the form of uric acid (*6*), enough ammonia is produced to maintain the urinary level at about 70 meq/l. In well-hydrated fasting alligators this ammonia is normally excreted with an almost equivalent amount of bicarbonate which is presumably produced through the influence of carbonic anhydrase in the nephron. Of the total osmotic pressure of the urine, which never exceeds that of the plasma, about two-thirds is due to the NH_4 and HCO_3 ions. As the alligator normally produces an alkaline urine (pH 7.80) due to the large amounts of NH_4 and HCO_3 ions, the proof of the existence of a base conservation mechanism in this animal is difficult to obtain.

It was felt that the injection of a carbonic anhydrase inhibitor into the alligator should change his urinary excretion pattern considerably. If carbonic anhydrase is necessary, directly or indirectly, for the production of both NH_4 and HCO_3 ions then the inhibition of carbonic anhydrase would lead to a great decrease in both these components in the urine. On the other hand, if carbonic anhydrase inhibition prevents the formation of bicarbonate in the tubule without affecting ammonia production the ammonia would then be excreted with a different anion.

In a series of experiments several alligators with an average weight of about 1.5 kg were placed in a tank of water for 24 hr to hydrate them. Some were then removed from the tank, injected with 50 mg of 6063 per kilo, and kept dry under the same condition as the controls for the next 4 days. Urine was obtained by catheterization at frequent intervals and was analyzed immediately or quick-frozen until the analyses were done. Sodium and potassium were determined by flame photometry, chlorides by a modification of the method of Schales and Schales (*7*), ammonia by the method of Conway (*8*), CO_2 content by the Van Slyke manometric method, and phosphorus by the method of Kuttner and Cohen (*9*). A Beckman pH meter with the glass electrode designed for blood analyses was used for all pH determinations. Figure 1 shows the effect of 6063 on the experimental alligators compared with controls during the first 24 hr.

It is apparent that carbonic anhydrase inhibition leads to a great decrease in CO_2 excretion without effecting a corresponding reduction in urinary ammonia. The chloride ion has been substituted almost quantitatively for the bicarbonate. This exchange, which is almost the exact reverse of that found in mammalian experiments, results in a decreased urinary pH and a mild alkalemia. By the 3rd day there was a rise of about 7 meq/l in plasma bicarbonate and a very slight and possibly insignificant fall in plasma chloride. No change in the other plasma electrolytes occurred.

[1] We wish to thank Lederle Laboratories Division of the American Cyanamid Company for a generous supply of Diamox.

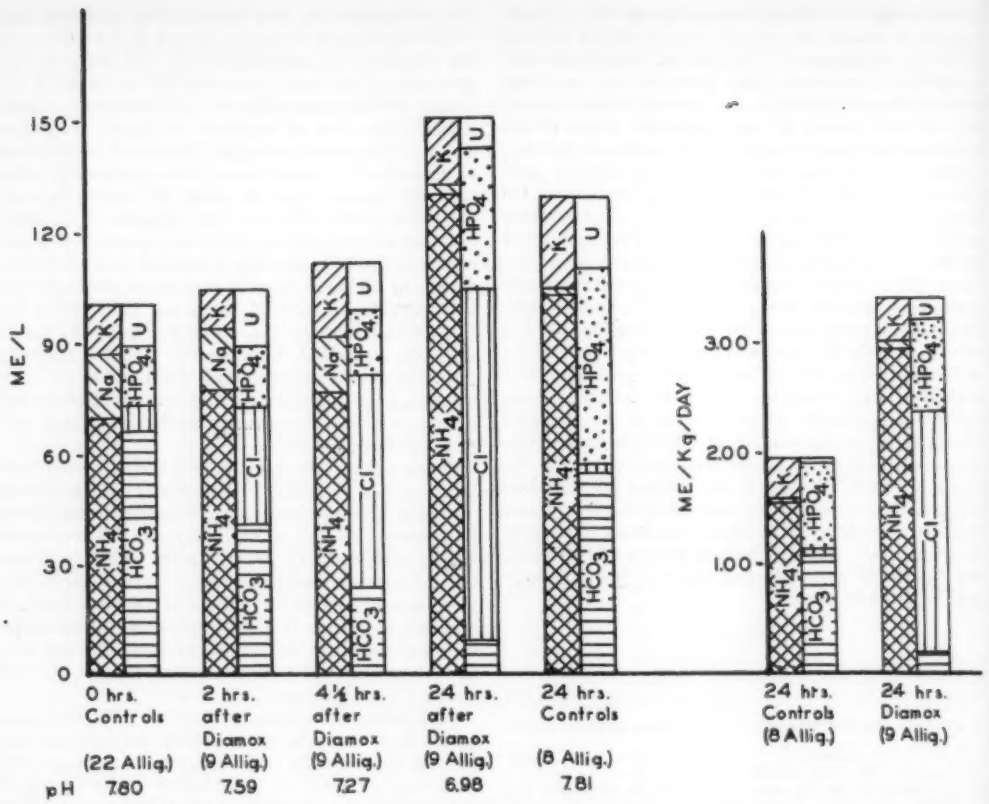

FIG. 1. The effect of 6063 on the urinary excretion pattern of the alligator. The average valence of HPO_4, used in determining the meq/l, was calculated from the observed urinary pH values. U represents undetermined anions.

Neither sodium nor potassium is excreted in increased amounts, which may account for the fact that 6063 has only a feeble diuretic action in the alligator. The dehydration due to 24 hr of water deprivation and the slight diuresis caused the urinary osmolar concentration of the experimentals to rise to approximately that of the plasma. No significant changes occurred in any of the other urinary constituents.

The changes in urinary composition due to a single injection of 6063 are apparent for at least 4 days. Repeated injections show progressively less effect; although the chloride excretion remains high the pH and the CO_2 content of the urine slowly rise. Reversion of the composition of urine electrolytes to the normal pattern after continuous administration of 6063 to dogs has also been noted by Maren (*2*).

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Communications

Activation of Purified Prothrombin in Association with Synthetic Organic Compounds and Platelet Extract[1]

In the clotting of blood, fibrinogen is transformed to fibrin by means of the action of thrombin. The chemical reactions that occur when thrombin arises from prothrombin are not fully understood. Attempts are being made to elucidate the complex problem by isolating and studying purified prothrombin. Efforts are also being made to obtain the substances that participate in the activation of prothrombin in purified form.

When prothrombin preparations that contain Ac-globulin are mixed with calcium, platelet extracts, and a partially purified platelet cofactor, thrombin forms rapidly (*1*). The platelet cofactor, which we obtain from plasma in partially purified form, is considered to be the antihemophilic factor. We have discovered that certain synthetic organic compounds can substitute for it in the activation of purified prothrombin. If there are other known instances where an organic compound can substitute functionally for a protein, they must be rare. We are not aware of any comparable observation. Our finding also has implications related to the hemophilia problem on the basis that the search for therapeutic agents is encouraged. Moreover, technical difficulties are greatly reduced for studying the role of platelet derivatives in the activation of prothrombin.

Our studies have been extensive, but as an illustration of this work Linadryl (4-(2-(benzhydryloxy) ethyl) morpholine) serves as a typical example. A purified prothrombin preparation purposely high in Ac-globulin was made from bovine sources by methods previously described (*2*). The following activation mixture was made in the order stated: 1.0 ml purified prothrombin containing 3000 units/ml plus 0.5 ml of 0.153 *M* $CaCl_2$ dissolved in imidazole buffer (*3*), plus 0.5 ml of 0.1% Linadryl solution plus 0.5 ml platelet extract prepared as previously described (*1*). To this was added purified thrombin to give only 10 units/ml in the reaction mixture. The purified thrombin was obtained from purified prothrombin by activating the latter in 25% sodium citrate solution (*4*). Within 15 to 45 min the prothrombin transforms to thrombin. If thrombin is not added to the activation mixture the transformation of prothrombin to thrombin may not result in a full yield of thrombin. It seems likely here that thrombin is acting by its well-known effect on Ac-globulin. Linadryl is one of the compounds of the antihistamine group. We are continuing our studies with other related compounds. Benadryl (2-benzhydryloxy-N,N-dimethylethylamine HCl), Decapryn succinate (2-(a-(2-dimethylamino-ethoxy)-amethybenzyl) pyridine succinate), and Phenindamine (2-methyl-9-phenyl-2,3,4,9-tetrahydro-1-pyridindene hydrogen tartrate) are also effective. Histamine itself can also be used.

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[1] Supported by research grant H-1467 from the National Heart Institute of the National Institutes of Health, Public Health Service.

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Received December 12, 1953.

An Open Letter to the Assistant Secretary for Research and Development, Department of Defense

I wish to bring to your personal attention a defect in the administration of the rule, based upon existing law, which requires certification, by a designated officer of the armed forces, that individuals working on secret parts of a government research contract are acceptable for access to secret security information in the custody of the contractor. It also suggests a partial remedy for this defect. The intent of the rule is, clearly, to make available to the contractor the services of trustworthy persons. The inordinate delay in such certifications which results under present conditions from even the most trivial facts or rumors turned up in routine investigations is especially crippling to research projects where the people of most value are not nearly interchangeable parts, like machine operators in a factory, and where the time available under a contract may be relatively short.

The situation objected to in the preceding paragraph has been forcibly brought to my attention as director of an urgent defense project supported since January 1951 under Contracts N7onr 288(09) and Nonr 609(02) between Yale University and the Office of Naval Research. This project has been in force for more than three years, but its continuance has had to be negotiated repeatedly, and its life expectancy is not now and never has been as long as a year. The Director of the New York Branch Office of Naval Research is the officer who must, in this case, decide as to secret clearances. He bases his decision upon a Personal Security Questionnaire, filled out by the individual and forwarded by the contractor, here Yale University, and upon such additional information as he can get from the Naval Intelligence Officer of the Third Naval District, also in New York City. Most of any detailed investigation of the individual's history, suggested by

study of his Personal Security Questionnaire and eventually channeled through these officers, is done by agents of the Federal Bureau of Investigation. If, as usually happens in the case of persons on the Yale faculty, or suitable for temporary appointment to render highly specialized services under a research contract, the investigation involves work outside areas administered from New York City, it appears to be the standard practice to make formal requests for such cooperation to officers in other Naval Districts, or overseas, so that in an extreme case there may be questions awaiting from half-a-dozen completely separate and completely uninterested offices, all overloaded with locally imposed tasks. No information as to the progress of any investigation short of completion is allowed to get back to the individual concerned or to the Contractor.

During the life of the project that I am directing, a total of more than 100 persons have, in spite of all this, been cleared for access to secret security information, but delays have tended to increase both in number and in duration, and during such delays the usefulness of the affected individual has been less, the progress of the project as a whole has been slower, and the public interest has been correspondingly damaged. There are now pending three cases more than a year old. For the record, and with the permission of the individuals concerned to make this disclosure, I can report that the individuals thus currently delayed are: Dr. Ray W. Jackson, a Canadian citizen; Professor Carl W. Miller, a member of the physics department of Brown University; and Miss Virginia Withington, an engineer and a Lieutenant in the Naval Reserve (not on active duty). Dr. Jackson's case, as that of an alien, is especially troublesome because the corresponding confidential clearance, within the competence of the Contractor for American citizens, is also currently jammed in this case.

I suggest, in the interest of speed, at least in urgent defense research projects, that, as soon as it appears that inordinate delay in the clearance procedure may occur, the responsible officer in the armed forces be authorized, if this is not already within his discretion, to interview the person under investigation, in order to supplement or clarify the information contained in the Personal Security Questionnaire, to permit open discussion of the delaying circumstances, to provide further guidance for, and more effective pressure upon, supposedly cooperating offices, and to assist generally in reaching a wise and early decision in the case. This would appear especially appropriate in view of President Eisenhower's recent statement on the necessity of allowing anyone accused, however obliquely, of conduct or association impairing his reputation, to know about and reply to the accusation.

During my association with the Navy, both in it and out of it, during the past 50 years, this is the first period in which I have observed it to be dilatory, uncertain, and panicky in handling security questions. I suspect that the same malady affects the Army and the Air Force. I think the reasons for this deplorable situation are sufficiently well known not to need discussion here.

I am sending copies of this letter to a number of people who may be interested, and may also submit it for publication in an appropriate place. I hope any comments that you may wish to make may be equally open to the public.

L. W. McKeehan, Capt. USNR (*ret.*)
Professor of Physics and Director of Sloane Physics Laboratory, Edwards Street Laboratory and Beavertail Laboratory, Yale University

Received December 14, 1953.

A Dew Recorder[1]

In the epiphytology of the potato and tomato late blight disease caused by the fungus *Phytophthora infestans*, information was needed on the relation of dew duration to secondary infection. As a result, a search was made for a dew duration recorder. An examination of the literature revealed only the descriptions of several instruments that record quantity of dew. Hence, a dew duration recorder was developed.

The instrument shown in Fig. 1 was constructed to record the onset and duration of dew deposition. The apparatus is simple in construction and operation. The dew detecting element is a strip of lamb gut attached to a pen arm. When dew is deposited on the membrane, it expands and releases the pen arm toward the chart which is attached to a drum driven by a 7-day clock. The pen, filled with common hygroscopic recording ink, traces the period of dew deposition. When the dew evaporates, the element dries and contracts, thereby pulling the pen arm and attached pen away from the chart.

Fig. 1. Wallin-Polhemus dew recorder.

[1] Journal paper no. 2398 of the Iowa Agricultural Experiment Station, Ames, Project 1163. Report of a study conducted under the Research and Marketing Act of 1946. The investigation was cooperative between the Iowa Agricultural Experiment Station and the Division of Mycology & Disease Survey, Bureau of Plant Industry, Soils and Agr. Engineering, U.S. Department of Agriculture.

In field tests in the summer of 1953, the instrument was placed between rows of tomato and potato plants. Within 5 min after visible dew appeared on surrounding foliage, the pen began tracing. In the morning, from 1 to 1.5 hr after sunrise, the pen ceased tracing within 5 min after the disappearance of visible dew from surrounding foliage. Usually at this time solar radiation was measurable in the plot.

The instrument has been designated the Wallin-Polhemus dew recorder and has been submitted to the U.S. Patent Office. Patent is pending.

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DALE N. POLHEMUS
U.S. Department of Agriculture
Ames, Iowa

Received January 11, 1954.

A Classified Bibliography of Inbred Strains of Mice[1]

The Roscoe B. Jackson Memorial Laboratory has compiled and maintains a bibliography of all papers appearing in books, journals, and reprints in which reference is made to specific inbred strains of mice, named genes in mice, or named transplantable tumors. This was started in 1948, and was intended solely for use by Jackson Laboratory personnel. However, because of its ever increasing magnitude (now approaching 5000 references), we feel that other investigators in the fields covered might be interested in using it. Any qualified investigator or student is welcome to use the bibliography. The references are fairly complete for the English-language publications, somewhat less so for other languages.

From the Keysort 5 by 8 in. cards on which the references have been classified, one can, by a small number of insertions of the stylus, sort out all the references on the use of any strain for some particular problem; on the incidence of various conditions in any strain; on any strain or named tumor; on the uses of any transplantable tumor; on all available comparisons of neoplastic and normal tissues; on any work with named genes; and so on. Use is made of two types of sorting: "direct," in which the subject or strain is individually named on the margins of the reference card, and "indirect," for which it is necessary to consult a key or index and needle a code number to locate references to the branch of a field of interest, or the particular minor strain, or the named transplantable tumor which one is seeking.

The mouse strains which are direct-punched are those available in quantity through the supply department of the Jackson Memorial Laboratory. These are in general the most widely used strains. Twenty-four other strains are coded in a numbered field. Particular named hybrids are indicated by punching the parent strains. Ten holes on the card have been left blank for future expansions of the classification system.

[1] It is a pleasure to acknowledge the generous financial assistance of the Ladies Auxiliary to the Veterans of Foreign Wars.

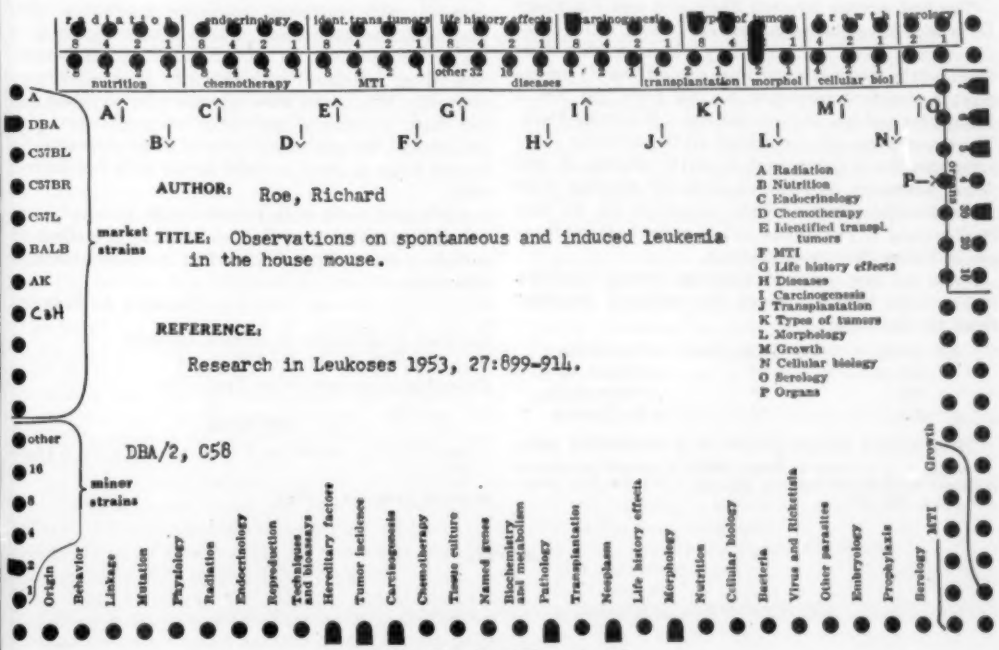

FIG. 1. Sample of Keysort card.

We have found it expedient to separate cards into periods of years (prior to 1930, 1930–34, 1935–39, 1940–44, 1945–49, and yearly thereafter). This helps a search considerably by eliminating periods in which the searcher is not interested. An index-key enables the user to find any subject quickly. This index also contains "key references," which aid in a general search of a wide field. The original hand-written cards from which the punch cards are typed are maintained as a separate author file.

JOAN STAATS

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Received November 12, 1953.

Tobacco Mosaic Resistance in Spain

WORK aimed at the production of mosaic-resistant strains of tobacco was begun in 1934 at the Spanish Tobacco Research Institute. Seed from the Ambalema tobacco was obtained in the spring of 1933 from J. A. B. Nolla, of the University of Wisconsin, who had discovered this resistant strain in the Cauca Valley of Colombia, South America.[1] Susceptible commercial strains were: a Philippine cigar tobacco of small thin leaves; Kentucky Dark; Cantabria, a selection from Kentucky tobacco, with large broad thick leaves; and M. Havana, a selection made in northern Spain from Cuban cigar tobacco. The strain Macrophylla, of large, slightly petiolate broad leaves, received from Scafati (Italy) is of no commercial value.

The first crosses involved Philippine and Kentucky Dark with the resistant Ambalema (Am.). After careful inoculation with the ordinary tobacco mosaic virus from Spain, two selections were made from F_2 progenies; a resistant segregate No. 60 from the Am. × Philippine and No. 61 from the Am. × Kentucky Dark. These segregates did not exhibit all the desirable characteristics for a commercial cigarette tobacco. It was found necessary to improve them by crossing with more desirable strains. Thus, segregate No. 60 was back-crossed to Philippine and to several other tobaccos including Mammoth Havana.

From the new series of crossings several desirable strains have been developed by continued selection from the following:

No. 230-B	(Am. Philippine)	× Philippine
226	"	× Cantabria
243	"	× Macrophylla
240	"	× M. Havana

These strains are not grown on a commercial scale in Spain but they serve as the nucleus around which it is hoped to produce desirable commercial forms.

All the strains mentioned, upon inoculation with the mosaic virus from this country, develop very mild symptoms of the disease. In this sense they are regarded as equal to Ambalema.[2]

ENRIQUE ALCARAZ-MIRA

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[1] Nolla, J. A. B., and A. Roque. 1933. A variety of tobacco resistant to ordinary tobacco mosaic. *J. Puerto Rico Dept. Agr.* **17**, 4, 301–303.

[2] Seed is available for distribution to research workers. *Director, Instituto Biologia del Tabaco, Seville, Spain.*

Received December 2, 1953.

The Influence of Cortisone, Antibiotics, and Granulestin on Antibody Production

IN a previous report (*1*) it was pointed out that short-term feeding of antibiotics to mice and rats resulted in increased antibody production. Since then antibody production has been studied in rats and mice fed natural foods, stock diets containing 0.1 percent Aureomycin, 0.1 percent Terramycin and 2 percent granulestin. Various combinations of these were tried with and without cortisone.

Cortisone injected rats were given chlortetracycline and oxytetracycline supplemented diet, control diet, diet containing both an antibiotic and granulestin. Salmonella enteritidis antigen was injected while the rats and mice were on the respective diets. In one typical experiment the titer of the rats given cortisone was approximately one-half that of the controls. Rats injected with cortisone receiving antibiotics plus granulestin in their diets yielded a titer higher than that of the controls. In mice it was found that cortisone alone interfered with antibody production very markedly. When mice were injected with cortisone and fed diets containing antibiotics or antibiotics plus granulestin, the agglutinin titers of those animals were several times as great as those of the mice fed control diet.

Additional work is in progress with rats and mice fed diets containing antibiotics to study the effect of cortone given orally and parenterally on resistance to infection.

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Book Reviews

Proceedings of the First International Congress of Electron Microscopy. Paris: Editions de la Revue d'Optique, 1953. 768 pp. Illus. $23.75.

The First International Congress of Electron Microscopy was held in Paris during September 1950 and was attended by more than 600 persons, mostly Europeans, from 17 different countries who contributed 135 papers. The papers have finally appeared in these *Proceedings* together with the inaugural addresses from L. de Broglie, G. I. Finch, and R. W. G. Wyckoff.

The volume is divided into five sections which consist of 240 pages on electron optics, 93 on electron diffraction, 91 on metallurgical applications, 93 on chemical applications, and 207 pages on biological applications. There are articles here which should be of interest to everyone concerned with the development of electron microscopy and the results obtained with this instrument. Some articles are only short notes, while others like that of Finch on Mechanical Wear and Lubrication review an entire field and the role that electron microscopy and electron diffraction have played in its recent development. In spite of rather poor paper the many illustrations are of excellent quality. It is to be hoped that printers of the proceedings of future Congresses will do as well, but in less time and at lower cost.

THOMAS F. ANDERSON

The Eldridge Reeves Johnson Foundation for Medical Physics
University of Pennsylvania

Organic Chemistry: An Advanced Treatise, Vols. III and IV. Henry Gilman, Ed. New York: Wiley; London: Chapman & Hall, 1953. 1245 pp., illus. + indexes. $8.75 a volume.

The well-known Volumes I and II edited by Gilman have gone through two editions in which different chapters appeared and advisory writers prepared parts in the two editions. This change in content of the two editions has necessitated some cross reference to the earlier edition. It is with pleasure that one notes the expansion of the series to Volumes III and IV with new material rather than classification of this new material as a new edition of Volumes I and II, and it is thus expected that future presentations in this series may continue as additional volumes. This will thus preserve the earlier contributions in this progressive series.

As in the earlier volumes, this work is directed by an editorial board under the able chairmanship of Henry Gilman, and each volume consists of specialized chapters or sections written by competent and well-chosen authorities in the subject assigned.

Volume III includes the following topics: The Study of Organic Reaction Mechanisms by Paul D. Bartlett; Application of Infrared and Ultraviolet Spectra to Organic Chemistry by Foil A. Miller; Lipids by J. C. Cowan and H. E. Carter; Organic Dyes by H. W. Grimmel; Some Aspects of Chemotherapy by H. R. Ing; and Antibiotics by Lee C. Cheney.

Volume IV includes: The Terpenes by Richard H. Eastman and Carl R. Noller; Heterocyclic Chemistry by Richard H. Wiley; Starch by W. Z. Hassid; Chemistry of Explosives by George F. Wright; Reaction of Organic Gases Under Pressure by W. E. Hanford and D. E. Sargent; and Oxidation Processes by William A. Waters.

As in the previous volumes, there is a balance between specific classes of organic compounds, such as dyes, lipids, terpenes, and starch, and applications of mechanisms or measurement techniques such as antibiotics, explosives, oxidation processes, and infrared and ultraviolet absorption spectra measurements. The authoritative status of the separate authors in the fields they write on makes the series of volumes a required reference work for all students and research workers who are engaged in programs involving these fields.

WALLACE R. BRODE

National Bureau of Standards
Washington, D. C.

Science in Alaska, 1951. Proceedings of the Second Alaskan Science Conference, AAAS, Alaska Division, 1953. (Order from: Dr. Troy L. Péwé, Box 4004, College, Alaska.) 362 pp. $3.00.

The second Alaska Science Congress, held in McKinley Park, was the first to be held in Alaska, the preceding meeting being in Washington, D. C.

This volume which contains the papers presented at the conference, will be a valuable reference for anyone interested in any phase of science in the Territory. It consists of reports of original research, a number of historical papers reviewing what has been done in the Territory in the past, and other papers outlining immediate needs in various major scientific fields.

A number of the original papers presented at this meeting came from the activities of the Aretic Health Research Institute, the Cooperative Wildlife Research Unit at the University of Alaska, and the Fish and Wildlife Service personnel in the Territory. The University of Alaska has also greatly expanded its activities in the scientific field and a wide range of activities have been carried on by defense personnel stationed in Alaska.

In addition to general and joint sessions the meeting was broken into nine subject matter units as follows:

1. Agriculture, Botany, and Forestry
2. Medicine, Physiology, and Public Health
3. Engineering, Industrial Science, and Aviation
4. Geology and Geography
5. Sociology, Economics, and Education
6. Anthropology
7. Geophysics
8. Meteorology and Oceanography
9. Wildlife and Zoology

Original research papers were especially numerous

in the field of public health and in wildlife and zoological problems, due unquestionably to the stimulating activity of the organizations mentioned above.

Papers covering original research are not confined to these two subjects but are rather widely scattered throughout the book. This book will be valuable to all students working in or proposing to work in Alaska, since it contains reports of progress and historical résumés of previous research which will provide a good starting point for students in many fields.

IRA N. GABRIELSON

Wildlife Management Institute
Washington, D. C.

Small Particle Statistics. Gustav Herdan; with a guide to the experimental design of particle size determinations by M. L. Smith. Amsterdam–Houston: Elsevier, 1953. 520 pp. Illus. $12.00.

The subtitle of this book is "An account of statistical methods for the investigation of finely divided materials—with a guide to the experimental design of particle size determinations." This last guide (pt. v) is written by M. L. Smith and gives a comprehensive survey of the most important methods for determining the distribution of particle sizes with special reference to the errors which are specific to the different methods. The following methods are discussed in slightly more detail: the microscope method (ch. 18), sedimentation methods (ch. 19), permeability method (ch. 20), photo-extinction method (ch. 21), and adsorption methods (ch. 22).

The main part of the book is devoted to a discussion of the statistical aspects of particle size determinations. This subject plays an important role in cement, glass, ceramic, rubber, and linoleum industries, industries dealing with polymerized materials, soil science, and sedimentary petrography. The author has tried, and as far as I can judge, succeeded in developing his subject without assuming any prior knowledge either of statistics or of advanced mathematics.

Part I of the book deals with the determination of the fineness of solids. Chapter headings are: Particles in the Sieve and Sub-Sieve Size Range; Some Fundamental Concepts of Statistics; The Units of Particle Statistics and the Principles of Particle Size Measurement; The Distributions of Particle Sizes and Their Averages; Sampling Procedures for Particle Size Determinations; Some Standard Forms of the Distribution Function; Graphical Representation; Statistical Testing and Analysis of Differences Between Determination Results.

Part II describes the technological importance of the fineness of solids with the following chapter headings: Methods for Ascertaining the Relations Between Variable Characteristics of Materials; Testing the Dependence of Properties of Materials upon Particle Size by Correlation Methods; Fundamental Relations Between Particle Size and Other Characteristics of Materials as Particulate Matter; Physical and Chemical Properties of Materials in Their Dependence upon the Characteristics of These Materials as Particulate Universes.

Part III discusses how a specific fineness (ch. 13) and homogeneity (ch. 14) can be attained. In chapter 15 the inhomogeneity of polymers is discussed.

Part IV is entitled Principles of Statistics of Coarse Disperse Systems. Chapter 16 discusses the principles of statistical theory and chapter 17 the statistical design of investigations of particulate materials.

The book is extremely well written and seems to cover a large amount of ground. It is difficult to single out particular chapters but the most interesting, and probably the most useful, chapters seem to me to be the ones dealing with a discussion of the relative merits of different methods of determining particle size distributions (ch. 8), the chapter discussing correlation methods (ch. 10), the chapter describing how the molecular weight distribution curve of polymers can be found (ch. 15), and the chapter dealing with the statistical design of experiments (ch. 17). By far the weakest chapter to my mind is chapter 16 where the discussion lacks the sharpness and precision which characterizes the rest of the book.

It seems that the author has succeeded in producing a handbook for people working in the field and both he and the publishers can be congratulated. The production is excellent and extensive indexes and a list of principal symbols further enhance the usefulness of this volume.

D. TER HAAR

Department of Natural Philosophy
University of St. Andrews, Scotland

New Books

Professional People in England. Roy Lewis and Angus Maude. Cambridge, Mass.: Harvard Univ. Press, 1953. 284 pp. $4.00.

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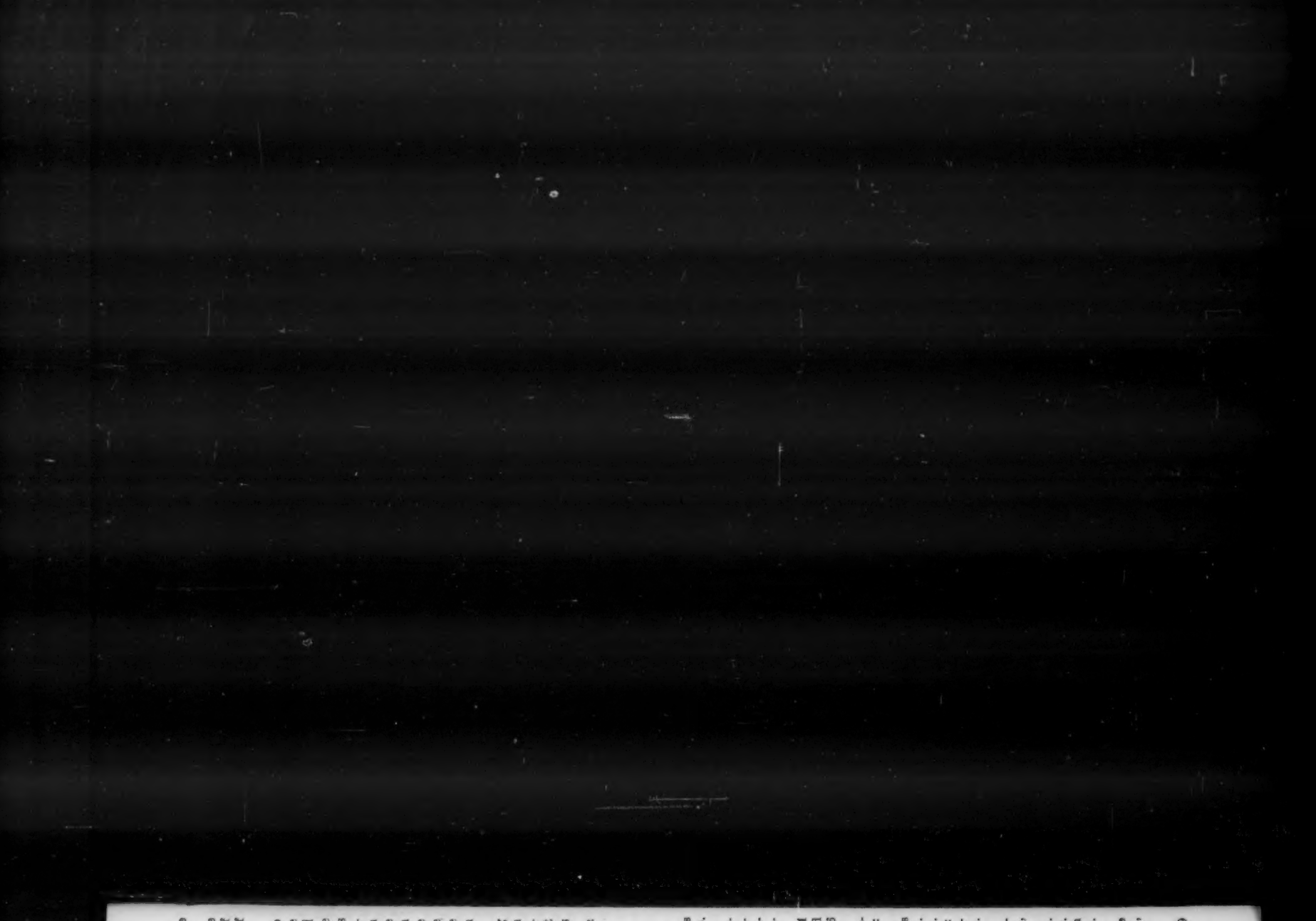

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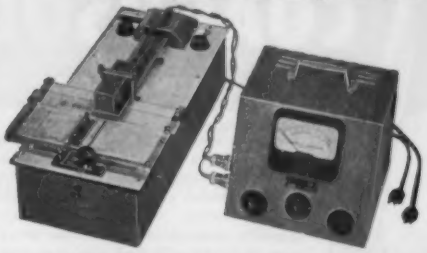

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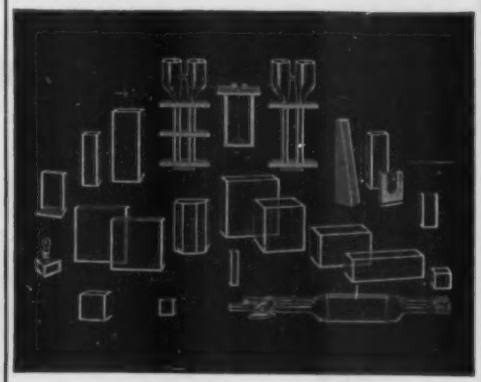

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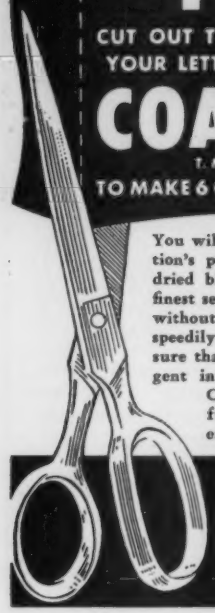

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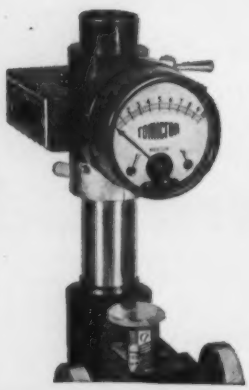

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Who Speaks for Whom or for What?

DURING the period when Bentley Glass was so ably giving the AAAS temporary editing service, he sent me a letter from a reader who raised interesting questions about the general problem of active participation of our journals, editorially or otherwise, in the lively contemporary issues that involve scientists. My reply to Dr. Glass, slightly emended and enlarged, follows. It touches, of course, only a few of the issues and procedures that connect with the broader question: How can the AAAS properly and effectively play a much more active role in controversial matters of concern to scientists?

Some persons seem to think that *Science*, and particularly the editorial matter therein, ought to "speak for Science." This seems to me an untenable idea, and a bad one. Just who would then be speaking for whom, or for what? By what authority would he speak? If the editor waited until he had the approval of the Board of Directors, the published statement would suffer considerable delay, and it would very likely also suffer considerable dilution in content.

In commenting on any such proposal I would want first to remark that I personally much prefer the word "science" to the word "Science." For we are dealing not with some mysteriously revealed body of absolute truth that deserves the deification of capital letters; but rather with that amazingly successful, interesting, intriguing, elusive, and rewarding human process by means of which, within one particular framework of reference, men approach truth.

This process moves in the direction of increasing precision and validity, but it does not reach perfection. It deals with certain very important aspects of experience—chiefly those that lend themselves to classification through quantitative regularities—but it excludes many other important aspects of experience. And science is developed by individual men, with all their bewildering and valuable individual differences. In some fields of science the techniques and criteria are so maturely developed that the influences of the individual origins have largely averaged out. But it remains true, and how fortunate that it does, that scientists do not all think alike even about science. When the issues involve science and other aspects of life as well, then it is almost notoriously true that scientists do not think alike!

Thus there just is not any such thing as the "Voice of Science," and anyone who pretends to speak with that voice is in for a row. What there is, and let us be thankful for this, is a large set of voices of individual scientists.

If you give these voices an open forum, conducted with reasonable rules of decency and freedom, I happen to be convinced that the statistical results would be excellent. You would not get unanimity, but you would get clarification, illumination, awareness, and concern.

I entirely agree that "if the AAAS is to be a vigorous force for the betterment of science, it cannot continue in the face of crucial situations with closed eyes and a dumb mouth." This means, of course, running various risks. Some scientists will say that science should stay right inside laboratories; just as some persons think that religion should stay inside churches. The liberals who disagreed would get angry; the conservatives, whether they agreed or not, would get worried. The AAAS would have little flurries of outraged resignations from time to time. But I am even more sure that there would be a steadily rising stream of new membership.

It is even possible, as the reader in question suggested, that we would need to protect our journals with some insurance against libel suits. If that should turn out to be necessary, then I think we ought to recognize that as a faintly nasty and irritating but necessary expense—sort of like having the grease trap cleaned at one's house or the garbage hauled away.

I do, however, think that we should proceed by offering a forum, rather than by pretending that we speak from the throne. I think that the editor, as an individual, should have free access to that forum. I think any other member should also.

WARREN WEAVER
President of the American Association for the Advancement of Science

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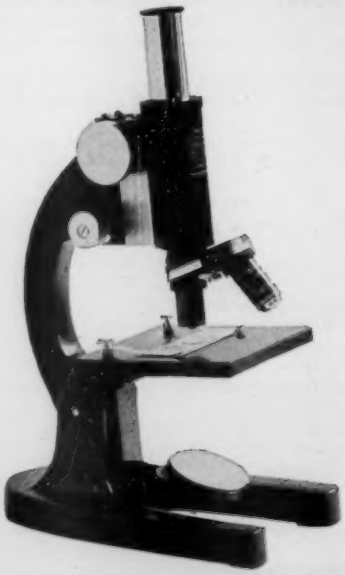

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25–27. Alpha Epsilon Delta, 10th national, Bloomington, Ind. (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.)

25–27. Optical Soc. of America, spring, New York City. (A. C. Hardy, Massachusetts Institute of Technology, Cambridge 39.)

25–27. Symposium on the Origins of Resistance to Drugs, Washington, D.C. (M. G. Sevag, Dept. of Microbiology, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

26–28. American Assoc. of Physical Anthropologists, annual, Yellow Springs, Ohio. (J. L. Angel, Jefferson Medical College, 307 S. 11 St., Philadelphia 7, Pa.)

27–28. American Psychosomatic Soc., 11th annual, New Orleans, La. (APS office, 551 Madison Ave., New York 22, N.Y.)

April

1–2. American Heart Assoc., 30th annual, Chicago, Ill. (R. Betts, AHA, 44 E. 23 St., New York 10, N.Y.)

1–3. National Science Teachers Assoc., annual, Chicago, Ill. (R. H. Carleton, 1201 16 St., NW, Washington 6, D. C.)

2–3. American Assoc. of University Professors, Buffalo, N. Y. (R. E. Himstead, 1785 Massachusetts Ave., NW, Washington 6, D. C.)

2–3. Assoc. of Geology Teachers, New England Section, 1st annual, Burlington, Vt. (C. G. Doll, Dept. of Geology, Univ. of Vermont, Burlington.)

3–10. Pan American Cong. of Veterinary Medicine, 2nd, São Paulo, Brazil. (J. S. Veiga, Rua Pires da Mota 159, São Paulo.)

5–8. Symposium on Orthopteran Acoustics, Jouy-en-Josas, France. (Laboratoire de Physiologie Acoustique, Institut National de la Recherche Agronomique, Jouy-en-Josas.)

5–10. International Sound-Recording Conf., Paris, France. (Société des Radio-electriciens, 10–14 Avenue Pierre-Larousse, Malakoff, France.)

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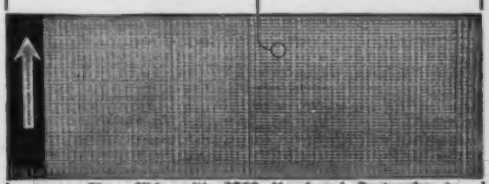

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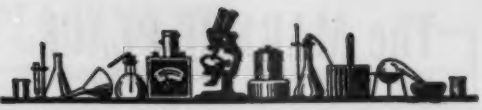

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